SARCOPTIFORMES (ACARI) OF SOUTH AUSTRALIAN SOILS.

1. NOTATION. 2. BIFEMORATA and PTYCTIMA (CRYPTOSTIGMATA)

By DAVID C. LEE

South Australian Museum, Adelaide, South Australia 5000

ABSTRACT

LEE, D. C. 1980. Sarcoptiformes (Acari) of South Australian soils. 1. Notation. 2. Bifemorata and Ptyctima (Cryptostigmata). *Rec. S. Aust. Mus.* 18(9): 199-222.

A study of sarcoptiform mites from surface soil (usually greatest depth = 4 cm) at 9 florally diverse sites in South Australia is introduced. A modified notation for mite morphology is presented. The following 6 species of Bifemorata or Ptyctima were collected and are either newly described or annotations are given: *Stomacarus abresi* n.sp., *Loftacarus siefi* n.gn., n.sp., *Ctenacarus araneola* Grandjean, *Protoplophora palpalis* Berlese, *Hoplophthiracarus shealsi* n.sp. and *Rhysotritia wallworki* n.sp.. Some relevant higher taxa are redefined. New synonyms are Aphelacaridae under Adelphacaridae, Ctenacaridae under Palaeacaridae and *Andacarus* under *Stomacarus*. New combinations are *campbellensis*, *ligamentifer* and *watsoni* (ex *Andacarus*) with *Stomacarus*, *longicaudatus* (ex *Stomacarus*) with *Loftacarus* and *africanus* (ex *Ctenacarus*) with *Beklemishevia*.

INTRODUCTION

The aim of this study is to give a broad (yet, because of resources, necessarily superficial) indication of the sarcoptiform mite (Cryptostigmata and Astigmata) fauna of South Australian soils. This group was selected because it is startlingly poorly known in Australia and because its members, with two small groups of mites (Notostigmata and Endeostigmata), are the only arachnids capable of ingesting solid particles.

The limited extent of knowledge about Australian Cryptostigmata is illustrated by comparing the known mite fauna of Australia and that listed from New Zealand by Spain and Luxton (1971). Of the 832 species of New Zealand mites, 380 species are Cryptostigmata. Whilst, of approximately 1 300 species of Australian mites, 19 species are Cryptostigmata. This situation will be partially rectified by a study of Cryptostigmata of the Pacific area by Professor Janos Balogh and Dr. Sandor Mahunka of Hungary. It is to be published in the near future, and refers to 200 or more species from Australia, mainly from east coast forest regions (personal communication). As elsewhere, the Astigmata of Australian soils are neither as abundant nor as diverse as the Cryptostigmata. In fact the only abundant species found in this study, and then only at the pasture site, was the cosmopolitan *Tyrophagus similis* Volgin.

The Cryptostigmata and Astigmata in soils feed on decomposing plant material, fungi, algae, bacteria and frass. Solid particles are fragmented and ingested, and are evident as relatively opaque boli in cleared specimens. Unlike purely liquid-ingesting mites they deposit faecal pellets similar to the frass of some insects and containing living micro-organisms. In other words, this group mechanically breaks down plant material, metabolize some of it, and feeds on and disperses organisms that also metabolize it. Furthermore, it is likely that the food preferences of particular species are limited, some, for example, feeding on only fungi, or even only certain fungal species. Therefore a study of variations in their fauna between different sites is pertinent to assessing variations in the decomposing processes that lead to nutrients being made available to growing plants.

During the sorting of samples nearly 30 000 adult Cryptostigmata and Astigmata were separated out and grouped in about 120 species. Relatively few immatures were collected and these are referred to only when they can both be identified and belong to a species that would not otherwise be represented from a particular site.

The author intends to classify the species in a number of publications and then comment on their distribution.

The higher classification used will be defended only as it deviates from that in "The oribatid genera of the world" by Balogh (1972). Since Balogh's classification, although comprehensive, does not answer the plea by Woolley (1971) for improvement in the ill-defined and complex system of classification for the Cryptostigmata, definitions of higher taxa will be presented and there will be a bias towards simplification by reducing the number of superfamilies and families.

All material is deposited in the South Australian Museum, Adelaide.

This particular publication presents the notation used for mite morphology and collection data. Then the six species of mites collected that belong to the Bifemorata and Ptyctima are classified and described when necessary.

NOTATION FOR MORPHOLOGY

Unless specified, attributes belong to adults. Much of the description of the soma is dealt with under four headings related to the areas illustrated (Fig. 1). The term *external mala* (see Hughes 1959: 139) is used rather than 'rutellum', and *spermapositor* rather than 'penis' since the relevant structure is not an intromittant organ. The term *cowl* is used for a proteronotal rostral hood which encompasses the retracted gnathosomal appendages, a condition previously referred to as 'stegasimy'. A partly new notation for hairs, chaetotaxy and pores is presented below, plus that for mensuration.

Hairs

Hairs are regarded either as *setae* if they have actinochitin and are hollow with no protoplasmic core, *solenidia* if they have no actinochitin and a protoplasmic core, *plasmic setae* ('eupathidia', 'famuli' and 'sensilli') if they have both actinochitin and a protoplasmic core. All hairs examined in this study exhibited only peripheral birefringence under polarized light, so they apparently always lack an actinochitin core. Solenidia usually occur dorsally on the distal segments of appendages, and are all referred to by the symbol *so*, and numbered, the more proximal and anterior solenidia first.

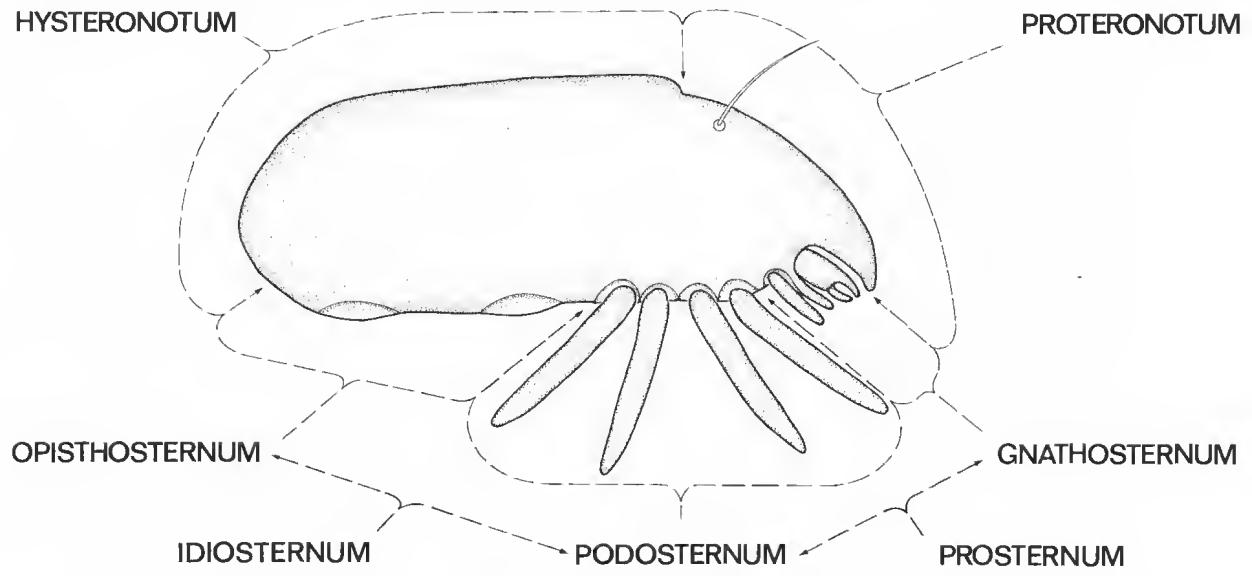


Fig. 1—Zones of soma surface.

Chaetotaxy of Soma

Up to four systems of notation for dorsal setae of Cryptostigmata have been used in a single publication, and a fifth system is usually used for the Astigmata. This has sprung from a desire to link the systems of notation with only confident proposals of homology. On the other hand, confusion results from multiple systems, and this has led me to follow a single system with less stringent proposals of homology. This system was initially applied to the opisthonotal shield of species of *Zercon* by Sellnick (1944) and then modified and extended to the notum of other members of the Gamasina (Mesostigmata) by Hirschmann (1957) and Lindquist and Evans (1965). Amongst sarcoptiform mites it has been used only for the Pelopoidea (Cryptostigmata) by Schweizer (1956) and Hammer (1972). It is based on a grid in which the ranks are represented by numbers and the files by letters derived from German words (*J*, inner = central; *Z*, zwischen = between; *S*, seiten = lateral; *R*, rand = edge). Capitals are used for hysteronotal files and lower case letters for proteronotal files. The complete dorsal chaetotaxy (holotrichous condition) is regarded as three pairs of files with two proteronotal ranks and six hysteronotal ranks. Further setae may be present: if lateral to file *S*, and possibly representing a further file, they are referred to file *R*; if they clearly reflect a hypertrichous condition they are represented by the notation for the file lateral to them combined with 'x' as in *Jx*. When only a few setae are missing compared with the holotrichous condition, the absence of a setal pair is illustrated by a circle and superimposed cross in order to indicate the numbering used in the text. For example, in Fig. 2, the third seta in file *Z* is *Z4* not *Z3*, *Z3* being regarded as missing and represented by a circle and cross. Also on illustrations, a number as a prefix to the file signature, for example as in 5*Z*, indicates how many setae are present in the file.

The ventral setae are either strictly somal setae or they are born on coxal regions which merge in with the soma. The opisthosternal setae belong to the former group and have notations similar to those of the hysteronotal setae except that they are regarded as either aggenital or adanal, the *g* or *a* representing one or other group being prefixed by either *J*, *Z* or *S*. The genital setae, those actually on the ovipositor

or spermapositor, are either proximal *(pg)*, median *(mg)* or distal *(dg)* and are numbered from the anterior. The podosternal setae are labelled by a roman numeral representing the leg articulating with their coxosternal zone, sometimes followed by a number representing ranks of which the first is at the adaxial end, and then by either *a* (anterior), *m* (median), *p* (posterior) or *d* (dorsal). The gnathosternal setae are regarded as adoral *(ao)*, postoral *(po)*, palp coxosternal *(c)* and supracoxal (cd), the numbers and letters applied to palp coxosternal setae are as for the podosternal setae.

Chaetotaxy of the Appendages

The widely used notation for the leg setae of sarcoptiform mites is based on french words such as 'unguinale' and 'fastigiale'. It was devised by Grandjean in 1935 and later modified to make the notation for the lateral surfaces of legs I and II match the homologous surfaces of legs III and IV (Grandjean 1940a). Because the system is esoteric and linked to debatable proposals of homology, I have used a system which is a manifest reference to setal position. Although in some instances I have not been able to rigidly keep to this. For example, the proximal dorsal seta, *d1*, on tarsus I ('famulus') has been regarded as occurring in different positions (compare Figs. 7, 27 and 42).

The widespread convention amongst specialists describing characters on arthropod appendages is to refer to their position as if on a cylinder-like segment and to use co-ordinates of two signature systems based on their location both on a hypothetical circular cross-section of the cylinder and on the straight proximal-distal axis. Two such notations have been ignored by acarologists. One was proposed by Newell (1956 and 1957) for *Oppia* (Cryptostigmata) and the other by Southcott (1961) for the Erythraeoidea (Prostigmata). On the other hand, a notation that dramatically improved methods of distinguishing families of Gamasina, proposed by Evans (1963), is now used generally for the Anactinochaeta. The Anactinochaeta is the other of the two major groups of mites. Sarcoptiform mites belong to the Actinochaeta which have optically active chitin in their setae. Amongst the Anactinochaeta a single whorl of setae at a particular position on the proximal-distal axis is considered (Evans 1963) to be basically made up of 6 setae (2 dorsal, 1 anterior, 2 ventral, 1 posterior). Amongst the Actinochaeta a single complete whorl is considered as including 7 setae (1 dorsal, 2 anterior, 2 ventral, 2 posterior) as on tibia I of *Palaeacarus* (see Grandjean 1940b; Fig. 1). On the other hand the 'fastigiale', 'tectale' and 'iterale' setae on tarsus I (see Grandjean, 1954c; Fig. 5A) are apparently 3 pairs of dorsal setae. Therefore, I am regarding a single whorl as including setae that can be referred to one of 8 positions (2 dorsal, 2 anterior, 2 ventral, 2 posterior), although a complete whorl of 8 setae has not be described, and no claim is made here that such a whorl is a lost primitive condition. The notation used for the eight positions is *ad, pd; dp, vp; pv, av; va, da* as illustrated (Fig. 19). In each pair of letters the last one represents the major area. If there is only one seta present in a particular quarter of the circumference then only this last letter is given. Since paired dorsal setae only occur in the absence of paired anterior and paired posterior setae, it is possible that one or both of the paired dorsal setae *(ad, pd)* are homologous with a dorso-anterior *(da)* or a dorso-posterior *(dp)* seta or both on other segments. The apparently dorsal setae on the tarsus, for example, having migrated dorsalwards from a primitive lateral location. The whorls are numbered from the proximal to the distal end, tarsus I is regarded as having 4 whorls, or a maximum potential or 32 setae. Whilst there are usually considerably fewer than 32 setae, members of the Bifemorata may have more, a condition which is regarded here as hypertrichous.

Pores

Balogh (1972) classifies pores into the following groups (notation in parentheses): slit-like pores *(ia, ip, ips, ih)*; reduced sacculi pores *(Pa, P_1, P_2, P_3)*; sacculi *(Sa, S_1, S_2, S_3)*; areae porosae (Aa, A_1, A_2, A_3, *Ad, Al, App)*. Because some of these letters are already in use, I am using *'f'* (foramen) as a signature for all pore types. Slit or punctiform pores are prefixed by *h* (hysteronotal), *Za* (lateral adanal) or *Ja* (central adanal). Sacculi, which are always hysteronotal are prefixed by *s* and similarly area porosae by *m* (multiporose area). A number following the signature equals the rank of a particular pore and a number before indicates how many pores are in the file. The pore of the lateral hysteronotal gland duct is referred to as *hGf*.

Mensuration

Measurements are in microns (μm). The idiosomal length is an average of the number of specimens which are indicated afterwards in parentheses with their range of lengths. For members of the Ptyctima, hysterosomal and proterosomal lengths are given separately. The idiosomal length of the holotype, or about average size specimen for established species, from which the appendage measurements were taken, is given in parentheses before these measurements. Lengths for the chelicera are the longest axis of the movable digit and for the palp and legs are the distances from the base of the trochanter to the tip of the tarsus. The breadths are the greatest width of the femur or, in

the case of the Bifemorata, the telofemur. In the case of the mites longer than 250 μm measurements are to the nearest 5 μm for most lengths and nearest 2·5 μm for the cheliceral length and all breadths. For mites under 250 μm in length the measurements are to the nearest 2·5 μm for most lengths and the nearest 1·0 μm for the cheliceral length and all breadths.

NOTATION FOR DISTRIBUTION DATA

Under the heading of 'Material examined', collection data and registration numbers are given for all mites examined in detail. Under 'Distribution' a wider indication is given of where a species is known to occur using a notation for geographical location, South Australian sites that are part of this study, and numbers of mites and their distribution amongst samples. This notation is explained under three headings: 'samples', 'sites', 'geographical location'. The sampling process and sites will be considered in more detail in the final paper of this series that will be concerned with the distribution of the relevant mites.

Samples

Samples were collected in plastic bags in a manner similar to a method I previously used (Lee 1973). They were, therefore, disturbed and would not have yielded such a high proportion of their mite fauna as undisturbed core samples. The top 4 cms of soil, plant litter, moss and other plants with a similar growth form were collected from 25 × 25 cm squares. An exception to this was the Knott Hill cultivated pine forest site from which, because of the unusual depth of the litter, four samples of different layers to a depth of 16 cms were taken from each 25 × 25 cm square. Usually samples of eight 25 × 25 cm squares were taken from each site, so that the number of adults of a particular species of mite at a site represents an extraction from half of a square metre of soil surface area, but collections from only two 25 × 25 cm squares were taken from the Knott Hill cultivated pine forest site.

The numbers given after the site, for example 10 (5/8), equal the number of adults collected and, in parentheses, the number of 25 × 25 cm squares of soil surface that the adults were taken from as a fraction of the total number sampled (usually 8, but 2 in the case of the pine forest site).

Sites

Sites were selected in order to represent floral diversity using the description of South Australian vegetation by Specht (1972). They also present a wide range of geographical locations. All nine sites are given a brief description below. The mites referred to in this publication were only collected from five of the nine sites, but the value of the negative results is emphasized. No attempt has been made to register seasonal variations in populations. In all instances sampling was done when the ground was relatively damp and therefore the sarcoptiform mite population was presumably relatively large. The sites with the lowest rainfall are listed first for those with native flora, whilst the two final cultivated sites have the one with the highest rainfall listed first. Annual rainfall figures given below are ranges of average annual rainfalls that include such a value for a particular site. Prior to cultivation the flora of the cultivated sites would have been similar to the savannah woodland in the case of pasture and sclerophyll forest in the case of pine forest.

1. Arid tussock grassland: Victoria Desert, 28° 41' S, 132° 08' E. Bases of love grass *(Eragrostis eriopda)* tussocks amongst patches of tall mulga *(Acacia aneura)* shrubland, on deep red siliceous sand of swale between ridges. Annual rainfall: 125-150 mm, sporadic. 11.10.1976.
2. Semi-arid low shrubland: Koonamore, 32° 07' S, 139° 21' E. Litter, moss and other low growth plants under bladder saltbush *(Atriplex vesicaria)* amongst false sandalwood *(Myoporum platycarpum)* low open-woodland, on rolling plain, with sandy clay loam on limestone pan. Annual rainfall: 150-200 mm, sporadic. 27.4.1974.
3. Mallee-broombush open-scrubland Ferries-McDonald, 35° 15' S, 139° 09' E. Litter and sparse moss, under ridge-fruited mallee *(Eucalyptus incrassata)* clumps amongst broombush shrubs *(Melaleuca uncinata)* on low hill with shallow calcareous sandy soil and sparse clayey subsoil on limestone pan. Annual rainfall: 350-400 mm, mainly winter. 20.6.1974.
4. Mallee-heath tall open-shrubland: Tamboore, 35° 57' S, 140° 29' E. Litter under banksia shrubs *(Banksia ornata)* amongst sclerophyllous shrubs and sparse brown stringy bark mallee *(Eucalyptus baxteri)* on ridge in area of deep calcareous sand. Annual rainfall: 450-500 mm, mainly winter. 4.7.1974.
5. Coastal closed-scrubland: Piccaninnie Ponds, 38° 03' S, 140° 57' E. Litter and sparse grass under coastal wattle *(Acacia sophorae)* with little light beneath canopy on black calcareous sand at landward edge of coastal dunes, sometimes inundated from permanent pond fed by fast flowing underground streams from limestone hills. Annual rainfall: 700-750 mm, mainly winter. 3.7.1974 and 20.8.1975.
6. Savannah woodland: Chambers Gully, 34° 58' S, 138° 41' E. Either litter under manna gum trees *(Eucalyptus viminalis)* or grass and moss in between these trees on shallow red brown loam of gully slopes in Mt. Lofty foothills. Annual rainfall: 900-950 mm, mainly winter. 12.6.1974.
7. Sclerophyll forest: Mt. Lofty, 34° 59' S, 138° 45' E. Litter and sparse moss under sclerophyllous shrubs amongst messmate stringybark *(Eucalyptus obliqua)* in forest near summit of Mt. Lofty on shallow, grey siliceous sand. Annual rainfall: 1150-1200 mm, mainly winter. 9.5.1974.
8. Pine forest: Knott Hill, 35° 12' S, 138° 41' E. Litter under cultivated *Pinus pinea* with little light beneath canopy on siliceous sandy soil on rolling hills in Mt. Lofty Ranges. Annual rainfall: 950-1000 mm, mainly winter. 22.5.1974.
9. Pasture: Glenthorne, 35° 02' S, 138° 32' E. Bases of cultivated grass and plantain *(Plantago lanceolata)* on deep brown loam on rolling hill in foothills of Mt. Lofty Ranges. Annual rainfall: 500-550 mm, mainly winter. 12.6.1974.

Geographical Location

Geographical regions are represented by 2 or 3 letters, the first of which, in capitals, equal the major

region. They are as follows: Nearctic (Nn—northern, Nc—californian, Nr—rocky mountain, Na—alleghanian); Neotropical (NTm—mexican, NTa—antillean, NTb—brazilian, NTc—chilian); Ethiopian (Ew—west, Ee—east, Es—south, Em—malagasian); Palaearctic (Pe—european, Pm—mediterranean, Ps—siberian, Pc—manchurian); Oriental (Oi—indian, Oc—ceylonese, Os—indochinese, Om—indomalayan); Australian (Am—malayan, Aa—australian, Ap—polynesian, An—newzealandian); subantarctic (Sm—magellanian, Sk—kerguelenian, Sa—antipodean); Antarctic (ACr—rossian, ACs—scotian). For details of divisions between these regions see the map that I have previously published (Lee 1970: p. 207).

SYSTEMATICS

Cohort BIFEMORATA

Diagnosis: Macropylina (Balogh 1972: 31). Pale adult with weakly delineated shields not completely encasing soma. Rostrum never longer than distance between setae *j*1-*j*1 and does not form cowl capable of encompassing retracted gnathosomal appendages. Genital and anal shields together almost as long as opisthosternum, and never separated by more than length of seta *Ja*1. No conspicuous idiosternal division. Coxae distally free from podosternum. Femur divided into basifemur and telofemur. Either tarsus I or tibia I or both with 4 solenidia. Between 20 and 40 setae on tarsus I. Immatures similar to adult.

Remarks: The classification by Balogh (1972) follows that of Grandjean (1969) to include six families grouped in three superfamilies, but the listing of *Beklemishevia* (under Ctenacarinae below) and *Tragardhacarus* (under Palaeacarinae below) under Aphelacaridae is original and probably constitutes a typing error. I have reverted to an earlier classification (Grandjean 1954c) in regarding the three superfamilies as families. But in introducing new characters to delineate these families, I have grouped Ctenacarinae under Palaeacaridae rather than with the Adelphacarinae. There are also less important changes in the classification. Whilst members of the Acaronychidae and Palaeacaridae were collected in the present study and are considered below, no adelphacarids were collected so they are briefly considered here. Adelphacaridae (Adelphacarinae Grandjean, 1954c: 198) includes two genera: *Adelphacarus* Grandjean, 1952b (not 1932 as given by Balogh, 1972) and *Aphelacarus* Grandjean, 1932b. It is known from the Nearctic and Palaearctic Regions. Aphelacaridae Grandjean, 1954c is newly synonymous with Adelphacaridae and is regarded as junior since it is listed after it on the same page, despite the fact that its type genus is much better known and for a longer time. *Adelphacarus* is based on a single specimen from Sweden with the region of the first rank of hysteronotal setae destroyed. Grandjean (1954c) distinguished Aphelacaridae by its having only two pairs of genital papillae and deep furrows rather than fine striations behind the proteronotal shield, which is not considered adequate here to distinguish a suprageneric taxon.

Key to Families of Bifemorata (Adult)

1. Aggenital file *Jg* includes 6 setae. If proteronotal shield present, it is not extensive enough anteriorly to carry either setae *j*1 or *z*1. Some hysteronotal setae conspicuously stouter than others. Seta *Z*2 shorter than *J*3 (0·75 × or less) and approximately level with *J*2 (*Z*1-*Z*2:*J*1-*J*2 = 0·9 or more:1) ..... Acaronychidae
   Aggenital file *Jg* includes 7 setae. Proteronotal shield present and carrying setae *j*1 and *z*1. If some hysteronotal setae conspicuously stouter then seta *Z*2 is longer and conspicuously displaced forward 2
2. Aggenital seta *Jg*1 hammer-like or claw-like. Some hysteronotal setae conspicuously stouter than others. Seta *Z*2 is subequal to or longer than *J*3 and conspicuously displaced forward (*Z*1-*Z*2:*J*1-*J*2 = 0·25-0·5:1) ..... Palaeacaridae
   Aggenital seta *Jg*1 setose. Hysteronotal setae all relatively slim. Seta *Z*2 shorter than *J*3 (0·6 × or less) and moderately displaced forward (*Z*1-*Z*2:*J*1-*J*2 = 0·6-0·75:1) ..... Adelphacaridae

Family ACARONYCHIDAE Grandjean

Acaronychidae Grandjean, 1932b: 426.
Archeonothridae Grandjean, 1954a: 428.

Type genus: *Acaronychus* Grandjean, 1932b.

Diagnosis: Bifemorata. Gnathosternal seta *ao*1 simple or bifid. Proteronotal shield absent or limited to posterior half of proteronotum. Rostrum has ventral recess with bilobed refractile lining (equals "oeil" of Grandjean, 1958b). Some hysteronotal setae conspicuously stouter than others, with seta *Z*2 shorter (0·75 × or less) than *J*3 and approximately level with *J*2 (distance ratio *Z*1-*Z*2:*J*1-*J*2 = 0·9 or more:1). Aggenital file *Jg* with six setose setae. On tarsus I seta *d*1 proximad to solenidium *so*1, subequal in length or longer than *so*1, and ciliate. Tibia II with 2 solenidia. Pretarsi with 3 claws, central claw less than quarter the length of lateral claws.

Remarks: Acaronychidae is used here as by Sheals (1965) and is equivalent to Archeonothroidea Grandjean, 1969 which is used by Balogh (1972). It is not known why Grandjean treats Archeonothridae as having priority over Acaronychidae or if there is any basis for Balogh (1972) giving it the authority with the apparently incorrect date of 1932. Sheals (1965) compared the genera of this family and considered that it might be preferable to consider them as a single relatively homogeneous group. I am currently retaining two subfamilies but including a new grouping of genera. A study of the four unnamed species from South Africa referred to by Grandjean (1958a: 76) might resolve which grouping

is best. One of these unnamed species was grouped in *Stomacarus* and is commented on below in the remarks on that genus, although it would be grouped in the Archeonothrinae as defined here.

Subfamily ACARONYCHINAE

Acaronychidae Grandjean, 1932b: 426.

Type-genus: *Acaronychus* Grandjean, 1932b.

Diagnosis: Acaronychidae. Female genital setae thickened to stout, curved spines, conspicuously shorter than the aggenital setae. The longest hysteronotal seta (*J3*) shorter than distance between setal bases *J* 3 and *z*1. Seta *J*2 marginally posterior to *Z*2. Opisthosternal setal file *Sa* includes 2 setae. On tarsus I, setae *ad*4 and *pd*4 not plasmic, but similar to setae *d*3.

Distribution: Southern temperate and subantarctic regions (see *Stomacarus*). In northern temperate regions represented by *Acaronychus* between latitudes 30° and 50° North, mainly in hilly or mountainous country (Oregon—Nc; North Carolina—Na; France—Pe; Tangiers, Algeria, Caucasus Mountains—Pm; Tadzhik Soviet Socialist Republic—Ps).

Remarks: The modification of the female genital setae is heavily weighted so that *Stomacarus* (assumed synonymous with *Andacarus*) is grouped in this subfamily for the first time. Members of the subfamily also have correlated attributes such as relatively short hysteronotal setae. The following 2 nominal genera are included in the Acaronychinae: *Acaronychus* Grandjean, 1932; *Stomacarus* Grandjean, 1952a.

STOMACARUS Grandjean

Stomacarus Grandjean, 1952a: 360.
Type-species: *Stomacarus tristani* Grandjean, 1952a, by monotypy.
Andacarus Grandjean, 1958a: 81. **n.syn.**
Type-species: *Stomacarus macfarlani* Grandjean, 1957, by monotypy.

Diagnosis: Acaronychinae. Ciliated seta *d1* on tarsus I with only slightly spatulate tip (no wider than distance between tips of nearby cilia). Proteronotal shield conspicuous, with reticulate markings and carrying at least seta *j2*. Setal pairs *J*1 and *Z*1 all on single hysteronotal shield. Delineated tip of mentum broad-based, wider than distance between setal bases *c1p* and *c2*. Lines from setal base *c1a* to *c1p* and *c2* would enclose an acute angle. Opisthosternal setal file *Sg* includes 2 setae.

Distribution: Southern temperate and subantarctic regions between latitudes 25° and 55° South. All records are with the original descriptions of nominal species except for *S. macfarlani* Grandjean, 1957, El Bolsón, Argentina—NTc (Balogh and Csiszár, 1963) and *S. ligamentifer* (Hammer 1967), Tahiti—Ap (Hammer 1972).

Found on ground, with dead leaves and branches, or on mosses, liverworts, low plants and lichens on bark.

Remarks: Only male attributes are known for the type species of *Stomacarus* based on a single specimen from Tristan da Cunha. Grandjean (1958a) examined two females of one amongst the four new species of South African 'Archeonothrinae' before him. They were small, their genital setae on the ovipositor were somewhat enlarged proximally but slim medially and distally as on the male spermapositor of similar species and, finally, their hysteronotal setae were similar to those of *S. tristani*. From these few attributes, and because the fauna of Tristan da Cunha is likely to be similar to that of South Africa, he grouped this unnamed species in *Stomacarus*. This led him to exclude *S. macfarlani* from *Stomacarus* because of its stout curved, genital setae and establish it as the type of *Andacarus*. If Grandjean (1958a) was correct, then according to the classification presented here, *Stomacarus* and *Andacarus* would be in separate subfamilies. Although three of the five characters used in the diagnosis of Acaronychinae are not known for *S. tristani*, the other two do fit, and at least one other mite, *Parasitiphis aurora* Lee, 1970, in a genus with a similar far southern distribution to *Andacarus*, is found in the Tristan da Cunha Island Group. Therefore, I have excluded the unnamed South African '*Stomacarus*' females (Grandjean 1958a) from *Stomacarus* and regarded *Andacarus* as synonymous with *Stomacarus*. If a female of *S. tristani* is found and none of its genital setae are thickened curved spines then the subfamily groupings as presented here will have to be disregarded.

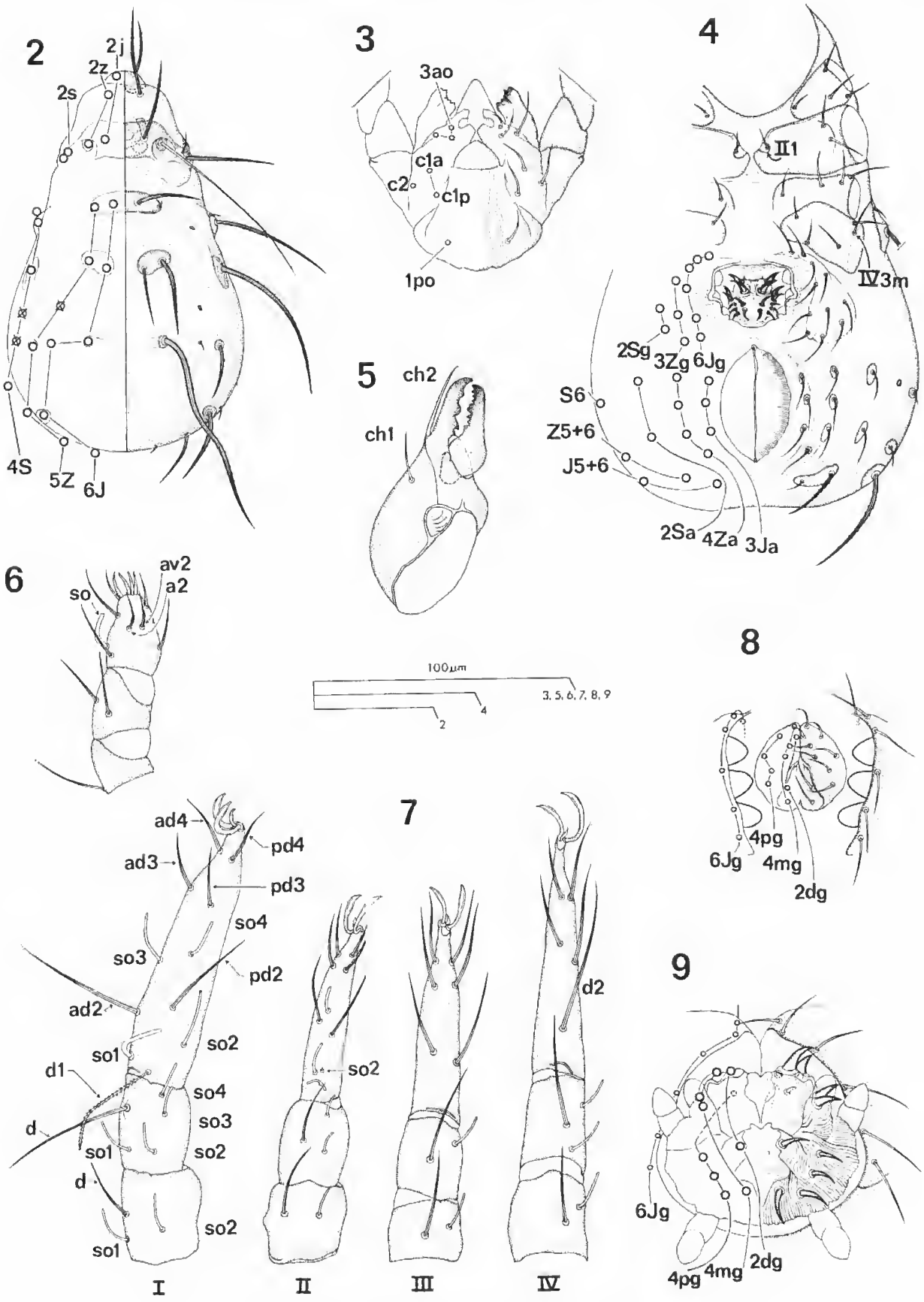
The following 6 nominal species are included in *Stomacarus*: *S. abresi* **n.sp.**, South Australia—Aa; *S. campbellensis* (Wallwork, 1966) **n.comb.**, Campbell Island—Sa; *S. ligamentifer* (Hammer 1967) **n. comb.**, New Zealand—An; *S. macfarlani* Grandjean, 1957, Argentina—NTc; *S. tristani* Grandjean, 1952a, Tristan da Cunha—Sk; *S. watsoni* (Travé, 1964) **n. comb.**, Macquarie Island—Sa.

Stomacarus abresi n.sp.

Figs. 2-9

Female

General appearance and measurements: Dull ivory-white, with apricot-coloured shields and legs. Extremities of chelicerae and external malae, hysteronotal setae and female genital setae blackish brown. Other setae and claws are light brown.



Figs. 2-9—*Stomacarus abresi* n.sp. 2-7 and 9, female: 2, notum; 3, gnathosternum; 4, idiosternum; 5, left chelicera, anterior surface; 6, part left palp, anterior surface; 7, legs, dorsal setae on genua, tibiae and tarsi; 9, ovipositor, ventral view, partially extruded. 8, male: spermapositor, ventral view.

Idiosomal length 350 (20, 305-370, amongst which those with only one or no eggs are 355 or less); appendage lengths (for 320)—*ch* 40, *pa* 105, *I* 290, *II* 210, *III* 190, *IV* 275; telofemur breadths—*pa* 22.5, *I* 40, *II* 32.5, *III* 30, *IV* 27.5.

Prosternum: Gnathosoma drawn (Fig. 3) is dorsoventrally squashed. Palp coxite seta *cd* shorter but stouter than seta *ao*1 and lying just dorsal to palp. Seta *ao*1 is simple and setose. Whilst extremities of external mala are strongly refractile, those of internal mala are hyaline. Coxosternal seta *Id* shorter but stouter than seta *ao*1 and lying just dorsal to leg I. Coxosternal seta *III* set in a notch in the edge of coxite II. On coxite IV there is a median seta *(IV3m)* in the distal whorl (unlike *Acaronychus tragardhi)*.

Proteronotum: Proteronotum drawn (Fig. 2) foreshortened because it was tipped ventralward. Plasmic seta, *z*2, finer than illustrated. Apodemes extend anteriorad from setal bases *j*2 and *s*2. Proteronotal shield between setae *j*2 has a reticulated pattern of punctations, and extends laterally to encompass base of seta *z*2 and carry setae *s*1 and *s*2.

Opisthosternum: Shields around genital orifice only vaguely delineated. Pore-like structure on ovipositor proximad to seta *dg*1 (possibly equals reduced seta on *Stomacarus macfarlani* Grandjean, 1957).

Hysteronotum: Shields not so clearly delineated as drawn and adaxial setae are foreshortened because of the angle of their axis (Fig. 2). Larger setae with two rows of small cilia.

Appendages: Chelicera with grooved notch on proximal edge of anterolateral surface. Setae: *ch* (2), *pa* (0-2-1-3-18), *I* (0-4-6-5-6-37), *II* (1-5-6-5-7-27), *III* (2-2-3-3-6-26), *IV* (3-3-3-4-5-25). Solenidia: *pa* (0-0-1) *I* (2-4-4), *II* (1-2-3), *III* (1-1-0), *IV* (1-2-0). On tarsus II solenidium *so*2 is very small (regarded as "famulus" by Grandjean, 1957: 217—i.e. seta *d*1).

Eggs: Amongst 20 type females, four have 0 eggs, five have 1 egg, six have 2 eggs, four have 3 eggs, one has 4 eggs. Eggs about 130μm long, ellipsoid with uniform smooth surface.

Male

Measurements and spermapositor (otherwise as female): Idiosomal length 340 (3, 345-360). All genital setae are setose, shorter but of similar diameter to aggenital setae. No equivalent of anterior pore noted.

Material examined: Holotype female (N197613), 19 paratype females (N197614-N197632), allotype male (N197633) and 2 paratype males (N197634 and N197635), moss and litter under *Eucalyptus obliqua*, sclerophyll forest, Mt. Lofty 9.5.1974, D. C. Lee. Undesignated female (N197636) and male (N197645) litter under *Eucalyptus incrassata*, mallee, Ferries-McDonald Reserve, 20.6.1974, D. C. Lee. Undesignated protonymph (N197784), litter under *Pinus pinea*, Knott Hill Forest, 22.5.1974, D. C. Lee.

Distribution: South Australia—Aa: Ferries-McDonald, mallee-broombush open-scrubland, 10 (5/8); Mt. Lofty, sclerophyll forest, 23 (5/8). Knott Hill, cultivated pine forest, 1 protonymph (—/2).

Remarks: In order to distinguish *S. abresi*, species of *Stomacarus* can be regarded as including two groups: those with a slim, tapering proteronotal seta *z*2, and those with a tape-like or lanceolate seta *z*2. The latter group *(S. campbellensis, S. ligamentifer* and *S. watsoni)* from New Zealand and its far southern islands have a narrow, square-shaped proteronotal shield only carrying seta *j*2, also the small hysteronotal seta *J*4 is either on the same shield as *Z*4 or its base is as close to setal base *Z*4 as its length. The former group includes *S. abresi, S. macfarlani* and *S. tristani*. *S. abresi* can be distinguished from *S. macfarlani*, which has a narrow proteronotal shield and seta *J*4 on the same shield as *Z*4 as in the latter group. *S. abresi* can be easily distinguished from *S. tristani*, which differs from all other known species of *Stomacarus* in having longer, sinuous, smooth hysteronotal setae. On the other hand *S. abresi* and *S. tristani* are similar in having a broader proteronotal shield and seta *J*4 further from seta *Z*4 and not on the same shield. *S. abresi* also differs from both *S. tristani* and *S. macfarlani* in having five setae on basifemur II rather than four setae. *S. abresi* also differs from *S. watsoni*, as well as *Acaronychus tragardhi*, in having a setose rather than a bifid seta *ao*1.

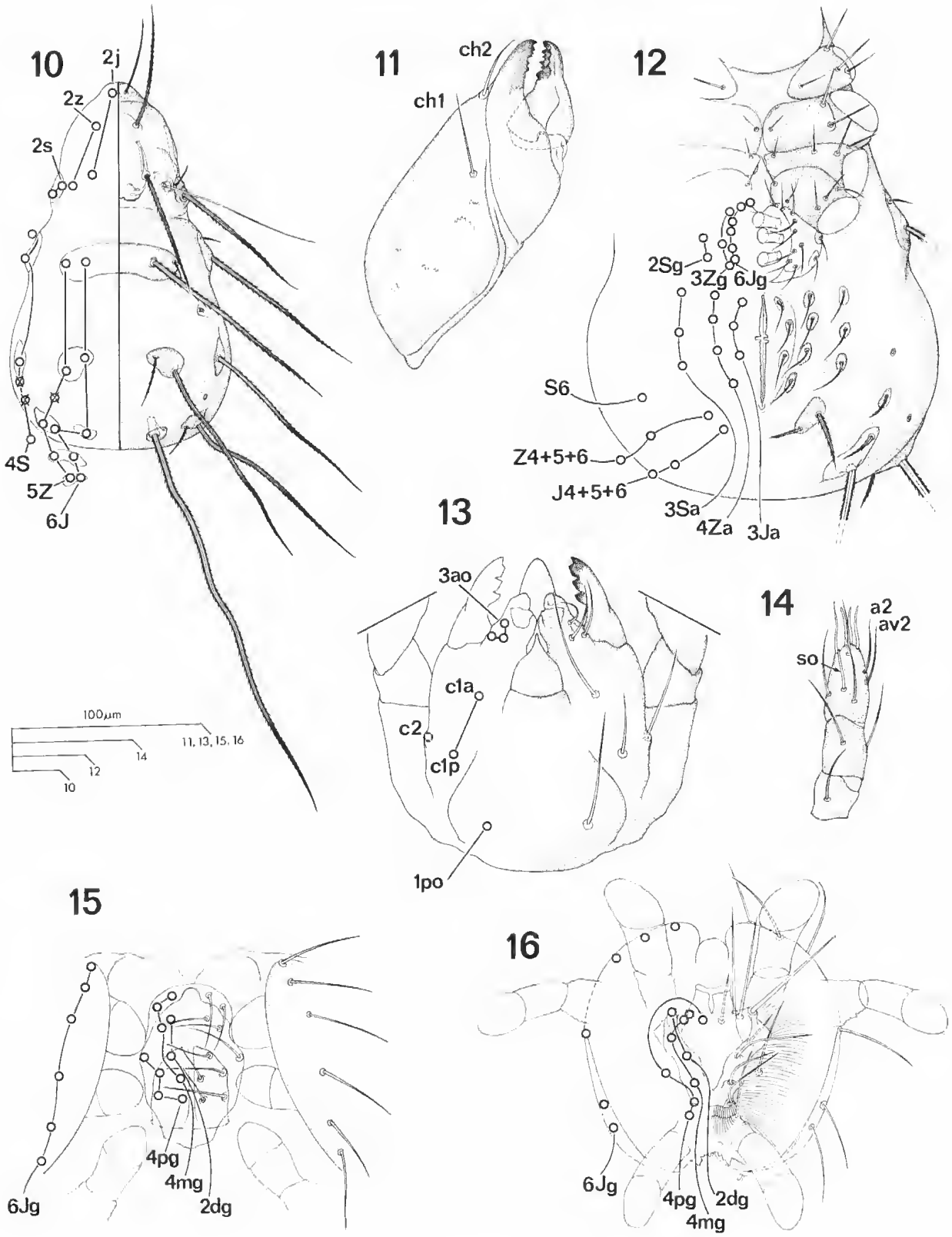
Subfamily ARCHEONOTHRINAE Grandjean

Archeonothridae Grandjean, 1954a: 428.

Type-genus: *Archeonothrus* Trägårdh, 1906: 871.

Diagnosis: Acaronychidae. Female genital setae may be slighty thickened to spines, but, if so, then straight and longer than aggenital setae. The longest hysternonotal seta (*J*3) longer than distance between setal bases *J*3 and *z*1. Seta *J*2 at least marginally anterior to *Z*2. Opisthosternal setal row *Sa* includes 3 setae. On tarsus I, setae *ad*4 and *pd*4 differ from setae *d*3 in being plasmic.

Distribution: Southern temperate regions; South America and South Australia (see *Loftacarus*) and South Africa (*Archeonothrus*, see Grandjean,



Figs. 10-16—*Loftacarus siefi* n.sp. 10-14 and 16, female: 10, notum; 11, left chelicera, anterior surface; 12, idiosternum; 13, gnathosternum; 14, part left palp, dorsal surface; 16, ovipositor, ventral view, partially extruded. 15, male: spermapositor, ventral view.

1958a). In Northern temperate regions represented by *Zachvatkiniella* and *Amuracarus* between 25° and 50° North, and 40° and 150° East, in mountainous country (Caucasus Mountains—Pm; Nepal—Os; far eastern Siberia, east of Lake Baikal and Sichote Alinja—Ps; Japan—Pc).

Remarks: I regard the relative lack of modification of the female genital setae as the most important attribute in diagnosing this subfamily. When the four unnamed species from South Africa referred to by Grandjean (1958a: 76) and probably belonging to this subfamily, are better known they may require changes in both the generic and subfamilial groupings within the Acaronychidae. The following 4 nominal genera are included in the Archeonothrinae: *Amuracarus* Lange, 1975; *Archeonothrus* Trägårdh, 1906; *Loftacarus* **n.gn.**; *Zachvatkinella* Lange, 1954 (=*Himalacarus* Sheals, 1965).

LOFTACARUS n.gen.

Type-species: *Loftacarus siefi* n.sp.

Diagnosis: Archeonothrinae. On coxite IV, 5 setae including seta *IV3m*. Opisthosternum with 2 setae in row *Sg* and 3 setae in row *Sa*. Proteronotal shield absent. Hysteronotal setal pair *J3* not on single shield and bases not connected by thickened strip of cuticle. Setae *J4* and *Z4* on same shield. Seta *Z6* tapering from base and ciliate. Cheliceral fixed digit with 6 or fewer teeth. Seta *v* present on telofemur II and III, and genu III, so that these segments carry 6, 4 and 4 setae respectively. Seta *av* absent from basifemur IV, leaving only 2 setae. Genu I with 2 solenidia. Tarsus II with 2 solenidia of which *so* 2 is very small.

Distribution: Southern temperate regions between 35° and 40° South (probably more extensive than this). All records with original descriptions of nominal species.

Remarks: Loftacarus appears most similar to *Amuracarus* although it can be distinguished from it by the two attributes given below. I have only seen one diagnosis of *Amuracarus* (Lange 1975) which quotes the authority of this name as "Lange, 1975" but does not give a reference in the bibliography or describe the single species, *A. voskresenskii* Lange, 1975. The description of *L. longicaudatus* is very brief. It is grouped in *Loftacarus* rather than *Amuracarus* because of the apparent absence of both a proteronotal shield and a thickened cuticular strip between the bases of setal pair *J3*.

The following 2 nominal species are included in *Loftacarus*: *L. longicaudatus* (Balogh and Csiszár, 1963) **n. comb.**, Argentina—NTc; *L. siefi* **n.sp.**, South Australia—Aa.

Loftacarus siefi n.sp.

Figs. 10-18

Female

General appearance and measurements: Dull ivory-white, with shields and extremities of legs tinged with pale brown. Extremities of chelicerae and external malae, and most hysteronotal setae are pitch-black. Most other setae are deep brown. A few setae and claws pale brown. Idiosomal length 700 (2, 695 and 700); appendage lengths (for 700)—*ch* 47.5, *pa* 245, *I* 635, *II* 470, *III* 465, *IV* 640; telofemur breadths—*pa* 37.5, *I* 85.0, *II* 80.0, *III* 57.5, *IV* 70.0.

Prosternum: Gnathosoma drawn (Fig. 13) is dorsoventrally squashed. Palp coxite seta *cd* shorter but stouter than seta *ao*1 and lying just dorsal to palp. Seta *ao1* is simple and setose. Coxosternal seta *1d* shorter but stouter than seta *ao1* and lying just dorsal to leg I. On coxite IV there is a median seta (*IV3m*) in the distal whorl.

Proteronotum: Apodemes extend anteriorad from setal bases *j2* and *s2*. Proteronotal shield is absent.

Opisthosternum: Shields around genital orifice only vaguely delineated. Describing genital setae is difficult because ovipositor only partially extruded. All genital setae are slightly stouter at base than the aggenital setae of file *Jg*. Setae *dg1*, *mg1* and *mg2* are longer than the aggenital setae and appear to be rigidly straight.

Hysteronotum: Shields not so clearly delineated as drawn. Adaxial setae hardly foreshortened at all because of the angle of their axes (Fig. 10). Conspicuous apodeme at base of seta *J3*. Larger setae are ciliate.

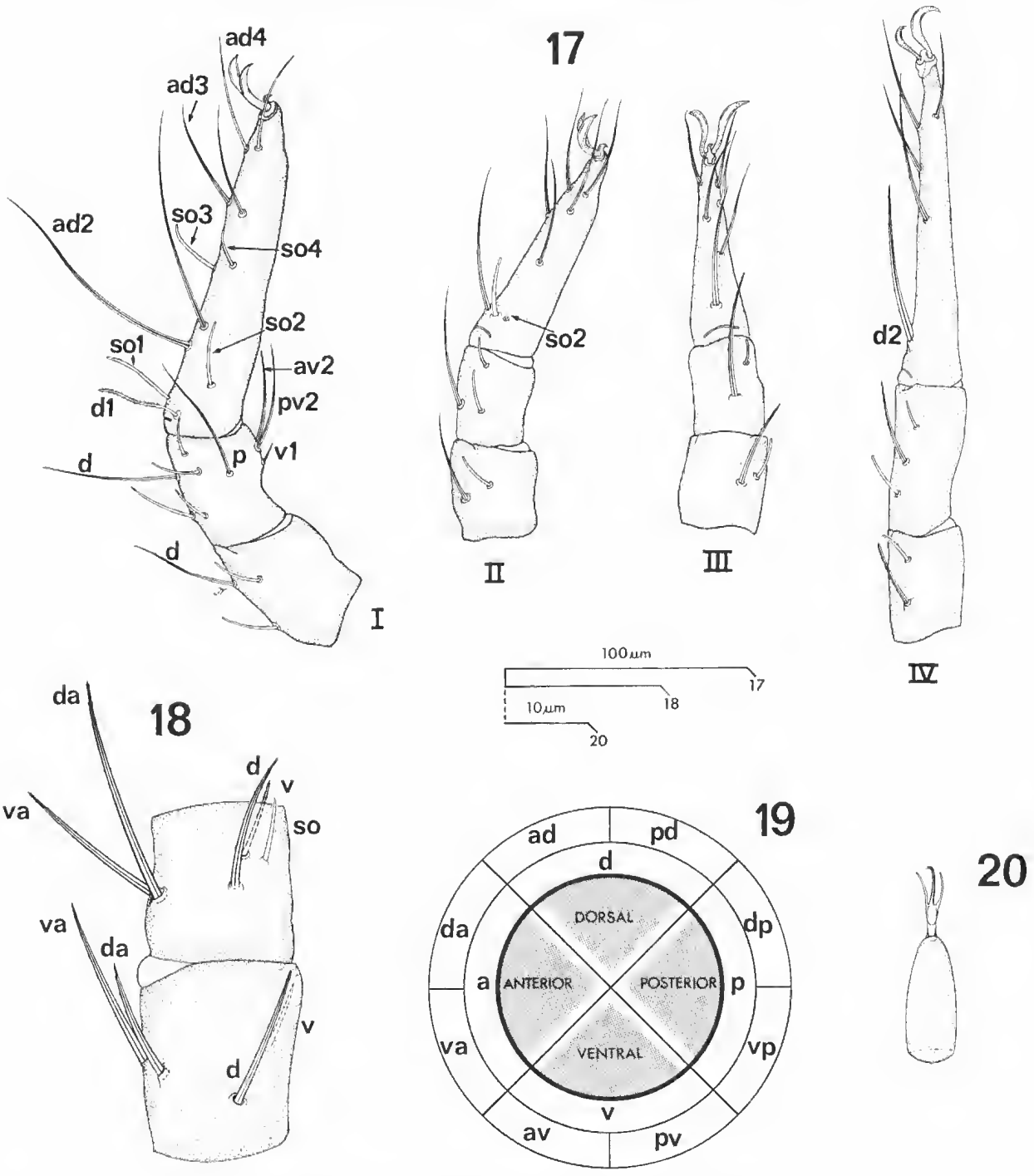
Appendages: Movable cheliceral digit carries two parallel rows of teeth. Setae: *ch* (2), *pa* (0-2-1-3-18), *I* (0-4-6-5-6-39), *II* (1-5-6-5-7-27), *III* (2-2-4-4-6-31), *IV* (3-2-3-4-5-28). On tarsus I some ventral setae and the *d*4 pair are plasmic setae. On tibia I, seta *v*1 unusually slim and short. Solenidia: *pa* (0-0-1), *I* (2-4-4), *II* (1-2-2), *III* (1-1-0), *IV* (1-2-0). Solenidium *so2* on tarsus II is very small.

Eggs: None seen.

Male

Measurements and spermapositor (otherwise as female): Idiosomal length 765(1). Spermapositor bears 10 pairs of setose setae. All genital setae are shorter than aggenital setae. Some genital setae in file *pg* appear longer than other genital setae: it has not been established whether this is true or if it is an impression related to the angle of their axes.

Material examined: Holotype female (N197646), paratype female (N197647) and allotype male (N197648), moss and litter under *Eucalyptus obliqua*, sclerophyll forest, Mt. Lofty, 9.5.1974, D. C. Lee.



Figs. 17-20—Appendages. 17 and 18, *Loftacarus siefi* n.sp., female: 17, legs, except for tibia I, dorsal setae on genua, tibiae and tarsi; 18, telofemur III and genu III, all setae. 19: zones of appendage surface. 20: *Protoplophora palpalis* Berlese, tarsus II.

Distribution: South Australia—Aa: Mt. Lofty, sclerophyll forest, 3(2/8).

Remarks: The other member of the genus, *Loftacarus longicaudatus*, is known only by attributes of the notum. There are a few apparent differences in the relative sizes of its notal setae and those of *L. siefi*, on which they appear somewhat shorter and stouter. The best diagnostic attribute is that seta *Z*1 is longer on *L. siefi*, being about 0·75 × the distance between setal bases *Z*1 and *J*1, while on *L. longicaudatus* *Z*1 is about 0·25 × this distance.

Family PALAEACARIDAE Grandjean

Palaeacaridae Grandjean, 1932b: 426.
Ctenacaridae Grandjean, 1954a: 428, **n.syn.**

Type-genus: *Palaeacarus* Trägårdh, 1932, 2.

Diagnosis: Bifemorata. Gnathosternal seta *ao*1 simple, ciliate or pectinate. Proteronotal shield present and extensive enough to carry all proteronotal setae. No bilobed refractile lining to a recess under rostrum. Some hysteronotal setae conspicuously stouter than others, with seta *Z*2 subequal to or longer than *J*3 and conspicuously displaced forward (*Z*1-*Z*2:*J*1-*J*2 = 0·25-0·5:1). Aggenital file *Jg* with 7 setae of which *Jg*1 is hammer-like or claw-like. On tarsus I, seta *d*1 distad to solenidium *so*1 or even *so*4, simple or lanceolate, may be considerably shorter than *so*1. Tibia II with 1 solenidium. Pretarsus with 2 or 3 claws, central claw may or may not be less than quarter the length of lateral claws.

Remarks: Palaeacaridae, as presented here, newly includes members of the Ctenacarinae; Grandjean, 1954c: 198, thereby further separating the latter from the Adelphacarinae and Aphelacarinae, which are here regarded as a single separate family (see remarks on Bifemorata). But, as pointed out below in the remarks on the Ctenacarinae, there are similarities between it and the Adelphacaridae. Possibly the Adelphacaridae should in the future also be included under the Palaeacaridae. Of the two palaeacarid subfamilies only ctenacarines were collected in the present study, so the Palaeacarinae is briefly considered here. Palaeacarinae includes two genera: *Palaeacarus* Trägårdh, 1932 (= *Tragardhacarus* Zachvatkin, 1945a) and *Palaeacaroides* Lange, 1972. It is known from the Holoarctic Region.

Subfamily CTENACARINAE Grandjean

Ctenacaridae Grandjean, 1954a: 428.

Type-genus: *Ctenacarus* Grandjean, 1939.

Diagnosis: Palaeacaridae. Internal mala consists of a broad proximal half and a slim distal half, the former carries all three adoral setae, with setal bases *ao*2 and *ao*3 posteriorad to base of external mala. Seta *ao*1 sparsely ciliate, ciliate or pectinate. Seta *d*1 on tarsus I never lanceloate, is either tapering or blunt ended and distad to solenidium *so*4.

Distribution: In the Northern temperate regions it is known from an area bounded by Tangiers (Pm), East Germany (Pe), Ukrainian S.S.R. (Pe), Turkmen S.S.R. (Ps) and Japan (Pc). Also it includes the only Bifemorata known from the tropics (Brazil and Venezuala—NTb; Rhodesia—Ee) as well as the below record from South Australia (Aa).

Remarks: Because of the long thick hysteronotal setae *Z*2 and *J*3 with *Z*2 conspicuously displaced forward, *Ctenacarus* looks superficially like *Palaeacarus*. This similarity is even stronger in other ctenacarine genera with less extensive hysteronotal shields and ciliate setae *Z*2 and *J*3. But because of similarities in the setae of tarsus I and in the internal malae and oral setae, Ctenacarinae has in the past been grouped with the Adelphacaridae. Here the hysteronotal similarities and those of aggenital setae *Jg*1 are regarded as important enough to regard *Ctenacarus* as not only superficially similar to, but infact more closely allied to *Palaeacarus* than *Adelphacarus* or *Aphelacarus*. The genera in this subfamily, especially *Gilarovella* and *Neoctenacarus*, are quite similar to each other. The following 4 nominal genera are included in the Ctenacarinae: *Beklemishevia* Zachvatkin, 1945b; *Ctenacarus* Grandjean, 1939; *Gilarovella* Lange, 1974; *Neoctenacarus* Moritz, 1974.

CTENACARUS Grandjean

Ctenacarus Grandjean, 1939: 543.

Type-species: *Palaeacarus araneola* Grandjean, 1932, by original designation.

Grandjeanacarus Zachvatkin, 1945b: 70.

Type-species: *Palaeacarus araneola* Grandjean, 1932, by original designation.

Diagnosis: Ctenacarinae. No ciliate hysteronotal setae. Setae *J*3, *Z*2 and *Z*6 simple or have inconspicuous paired hyaline flaps running parallel to main setal axis. Seta *J*6 is leaf-like, having conspicuous paired hyaline flaps. Setae *J*4, *J*5 and *Z*5 subequal in length to *Z*1. Opisthosternal chaetotaxy hypertrichous—e.g. 8*Sg*.

Distribution: Possibly cosmopolitan, only one nominal species (so see *C. araneola* distribution) but may be another species in Oregon—Nc. Found on ground, in dry or swampy environments, in soil mosses and other low plants and in a termite nest.

Remarks: Ctenacarus is easily distinguished from other genera in the subfamily by the form of its hysteronotal setae. *Beklemishevia africanus* (Mahunka, 1974: 206) **n.comb.** from Rhodesia was included in *Ctenacarus*. It is known only by attributes of the notum, although the venter is recorded as being as "Grundtypus". It is not confidently distinguishable from the type, and only other known species, *B. galeodula* Zachvatkin, 1945b. There is apparently a second, unnamed species of *Ctenacarus* from Oregon (Krantz, 1978: 475) on which the internal mala has an anterolateral flap ventrally obscuring the base of a pilose rather than a pectinate adoral seta *ao*1.

The following 1 nominal species is included in *Ctenacarus*: *C. araneola* (Grandjean, 1932b).

Ctenacarus araneola (Grandjean)
Figs. none

Palaeacarus araneola Grandjean, 1932b: 417.

Ctenacarus araneola (Grandjean): Grandjean, 1954c: 248.

Ctenacarus araneola (Grandjean): Mahunka, 1977: 464.

Male

Idiosomal length 315 (9, 290-320); appendage lengths (for 320)—*ch* 17.5, *pa* 65, *I* 160, *II* 110, *III* 115, *IV* 190; telofemur breadths—*pa* 12.5, *I* 25, *II* 20, *III* 17.5, *IV* 20. Although movable cheliceral digit is unusually short, the cheliceral digits are robust and distally pitch-black, as are the tips of the external malae. Hysteronotal setae *J3*, *Z2* and *Z6* have a narrow hyaline flap on each side as wide as the diameter of the seta. In five specimens the positor was recognised and it was as decribed for the male (Grandjean 1954c: fig. 22E).

Material examined: Nine undesignated males (N19761-N19769), litter or moss and litter, under *Eucalyptus incrassata*, mallee, Ferries-McDonald Reserve, 20.6.1974, D.C. Lee.

Distribution: Venezuela (NTb), Brazil (NTb), Morocco (Pm), Algeria (Pm), Japan (Pc), Kenya (Ee), South Australia—Aa; Ferries -McDonald, mallee-broombush open-scrubland, 9(2/8).

Remarks: Specimens referred to fit Grandjean's (1954c) description of this species except that three other pairs of hysteronotal setae, besides *J6*, have hyaline flaps. This observation is considered here to either reflect the improved microscopy of interference contrast or an intraspecific variation. All nine specimens are regarded as male because none contained eggs and five apparently had spermapositors and were similar to the other four on which the positors were not recognised.

Cohort PTYCTIMA

Remarks: The grouping of mites within this taxon as by Balogh (1972) reflects a long standing classification that is still widely held to. This is despite apparently well supported conclusions by Grandjean (1967, 1969) that the Ptyctima includes three groups more closely allied to other taxa than to each other. Using Balogh's (1972) taxa these conclusions can be summarised as follows: the Protoplophoroidea are allied to the Sphaerochthoniidae (Arthronota), the Mesoplophoroidea are allied to the Eniochthoniidae (Arthronota) whilst the Phthiracaroidea and Euphthiracaroidea are allied to the Collohmanniidae (Holonota). As stated in the introduction, I intend to try and reduce the number of superfamilies and families in the Cryptostigmata. If this is done, in combination with partly following Grandjean's (1969) later conclusions, the classification becomes very unfamiliar because the superfamily names in the Ptyctima tend to have older authorities. Therefore, for the time being, I am only following Grandjean's (1967) first change in the classification; the split of the Ptyctima into two subcohorts, the Arthroptyctima and the Euptyctima. In the next stage of this study, when members of the Arthronota and Holonota are described, I will try and reach a decision about Grandjean's (1969) later conclusions. It is possible that the Ptyctima should be disbanded and its members grouped in both the Arthronota and Holonota.

Subcohort ARTHROPTYCTIMA

Diagnosis: Ptyctima. Hysteronotal shield divided into separate anterior and posterior parts, but sometimes (Mesoplophoridae) posterior hysteronotal shield reduced and difficult to distinguish from ventral shields. Anterior hysteronotal shield carries only four to eight pairs of setae. When posterior hysteronotal shield inconspicuous there is an unbroken transverse shield between the genital and anal shield. On palp coxite, seta *cd* spine-like and less than X 0·25 length of *c2*. Genua of all appendages with either no or 1 solenidium. Nymphs ptychoid with rigid shields, although not always distributed as on adult.

Remarks: The above diagnosis includes the Protoplophoroidea Grandjean, 1965 and Mesoplophoroidea van der Hammen, 1959 as used by Balogh (1972). These superfamilies are maintained here because of Grandjean's (1967, 1969) conclusions, mentioned above, that they are each allied to one of two quite distinct groups within the Arthronota. The Protoplophoroidea includes one family which is considered below because one of its species was collected in the present study. The Mesoplophoroidea is considered briefly here. Grandjean (1965) regards this superfamily as allied to the Hypochthonioidea amongst the Arthronota, partly because of the striking resemblance between the unusual gnathosternum of *Mesoplophora* Berlese, 1904 and that of *Hypochthoniella* Berlese, 1910 (= *Eniochthonius* Grandjean). Grandjean (1965) also grouped a poorly known genus, *Archoplophora* van der Hammen, in the Mesoplophoroidea, but in a distinct family. Although the gnathosternum of *Archoplophora* is not described and the genital and anal shields only resemble those of the nymphs of *Mesoplophora*, the hysteronotal structure and setation with a lack of pleural shields provisionally groups it close to *Mesoplophora*. Members of *Mesoplophora* look superficially like small Euptyctima, but with anal and genital plates similar to the Brachypylina, rather than members of the Macropylina. The similarity to the Euptyctima is because they appear to have a single, undivided hysteronotal shield, with no ability to fold up posteriorly, and a proteronotal shield which folds downward to cover only a distinct anterior forward-facing section of the genital shield, without any pleural shields to provide lateral protective wings to the join. On the other hand, the reduced

hysteronotal chaetotaxy (8 setal pairs) indicates that the hysteronotal shield is homologous with only the anterior part of the hysteronotal shield of the Euptyctima. This supports the concept of an Arthronota-like ancestor, able to fold up the posterior part of the hysterosoma, which has since lost this ability because of the posterior hysteronotal shield being reduced and merged with the ventral shields. I am postponing an evaluation of the degree of alliance between the Protoplophoroidea and Mesoplophoroidea until a later stage in this study when the Arthonota have been considered.

Family PROTOPLOPHORIDAE Ewing

Protoplophorinae Ewing, 1917: 199.

Type-genus: *Protoplophora* Berlese, 1910.

Diagnosis: Arthroptyctima. Hysteronotum clearly divided into at least 2 articulated shields, the posterior shield capable of moving up under the anterior shield. Anterior hysteronotal shield carries 4 pairs (*J1*, *Z1*, *S1*, *S2*) or 6 pairs (plus inconspicuous *J2* and *Z2*) of setae. Large pleural shields cover space between proteronotal and genital shields when mite folded up. Genital shield flat but inclined dorsalwards from plane of anal shield and completely covered by proteronotal shield when mite folded up. If adanal shield separates genital and anal shields it is divided mid-ventrally into 2 parts. Pretarsus with 2 or 3 claws which may be unusually long. Palp genu carrying seta *d*. All genua without a solenidium. External mala is spatulate, broadening out distally to hyaline flap.

Remarks: The protoplophorids are unusual in being able to fold up their bodies posteriorly as well as anteriorly. Van der Hammen (1959) indicates that Berlese's protoplophorids, a major part of the known family, are insufficiently described. The most informative work is the redescription of *Aedoplophora glomerata* and *Cryptoplophora abscondita* by Grandjean (1954b). The classification is further confused because of the similarity between nymphs and adults and the possiblity that some attributes used to diagnose taxa, such as number of hysteronotal divisions or sutures, vary between these stages. With the exception of *Protoplophora*, all genera are recorded in tropical latitudes, only the record of *Cryptoplophora abscondita* from Algeria (Pm) is elsewhere. The extraordinary long claws of some species suggest that they may sometimes live on other animals. The following 6 nominal genera are included in the Protoplophoridae: *Aedoplophora* Grandjean, 1932a; *Arthroplophora* Berlese, 1910; *Cryptoplophora* Grandjean, 1932a; *Hauseroplophora* Mahunka, 1977; *Protoplophora* Berlese, 1910; *Prototritia* Berlese, 1916.

PROTOPLOPHORA Berlese

Protoplophora Berlese, 1910: 217.

Type-species: *Protoplophora palpalis* Berlese, 1910, by original designation.

Diagnosis: Protoplophoridae. Anterior hysteronotal shield carries 4 pairs of simple setae. Posterior hysteronotal shields carry 8 pairs of simple setae. Posterior hysteronotal shield either with two hinged divisions just posteriorad to setae *J3*, *Z3* and *J4*, *Z4* so that there are three articulating parts, or these two divisions reduced to a suture not extending to lateral margins. Lateral margins of adanal shields approximately parallel so that they meet a wide anterior margin to enclose almost a right angle. On chelicera, seta *ch2* simple and setose. On palp, distal setae shorter than tarsus. Pretarsal claws on legs less than x 0·5 tarsal length. Palp with 5 segments and relatively long (X 0·66 length of leg I).

Distribution: Previously known mainly from around western mediterranean between latitudes 30° and 40° North. The record below from South Australia is within the equivalent southern latitudes. Also recorded from Central Asia.

Found on ground in humus, litter and moss.

Remarks: Van der Hammen (1959) was of the opinion that since Berlese (1910) did not mention characters on the ventral surface of the type of *Protoplophora*, it is impossible to decide whether or not the specimen described by Grandjean (1932a) belongs to this genus. In contrast, I consider that enough attributes of the type are known (more than one hysteronotal division, simple hysteronotal setae—not hypertrichous, long palp without long distal setae, short claws) for Grandjean's grouping of his specimen in *Protoplophora* to be accepted.

The following 2 nominal species are included in *Protoplophora*: *P. bivaginata* Grandjean, 1932a, *P. palpalis* Berlese, 1910.

Protoplophora palpalis Berlese

Fig. 20

Protoplophora palpalis Berlese, 1910: 217.

Protoplophora palpalis Berlese: Grandjean, 1932a: 24.

Adult

Idiosomal length 185 (3, 185-190); appendage lengths (for 190)—*ch* 16, *pa* 40, *I* 60, *II* 57.5, *III* 50, *IV* 50; femur breadths—*pa* 5, *I* 13, *II* 10, *III* 9, *IV* 9. Proteronotal seta *z2* broadly lanceolate and in its normal drooping position the surface away from the proteronotum carries a row of inconspicuous cilia. One specimen (N197610) has a recognisable positor with at least four pairs of setae and there are only two pairs of genital papillae. It also has three clearly

delineated parts to the posterior hysteronotal shield which appear to be capable of telescoping up to overlap each other. Chelicerae have three teeth on fixed digit and one tooth on movable digit, and setae *ch1* and *ch2* are inconspicuous and setose. The external mala is spatulate with a long stalk (X 0.6 total length) and a pyriform hyaline flap distally. All the legs are tridactyl (Fig. 20) with a refractile, curved central claw and hyaline, slim and almost straight lateral claws.

Material examined: Three undesignated adults (N197610-N197612), litter, under *Eucalyptus incrassata*, mallee, Ferries-McDonald Reserve, 20.6.1974, D. C. Lee.

Distribution: Sicily (Pm). Spain (Pm). Central Asia (Ps). South Australia—Aa: Ferries-McDonald, mallee-broombrush open-scrubland, 3(1/8).

Remarks: The specimens referred to here fit the description of the specimen from Spain by Grandjean (1932a) rather than the type. On the basis of the standard of the descriptions this may only indicate that Berlese (1910) was not so accurate. The fact that both authors represent their specimens as monodactyl is also regarded here as as inaccurate, resulting from the smallness of the mite and the use of only bright field rather than the more revealing interference contrast illumination. But it is possible that three distinct species are represented.

Subcohort EUPTYCTIMA

Diagnosis: Ptyctima. Hysteronotal shield undivided and carrying at least 12 pairs of setae. Genital and anal shields either fused together or abut onto each other. On palp coxite, seta *cd* setose and more than X 0.25 length of *c2*. Palp with 3 to 5 segments, if genu present it does not carry any setae. Genu I carries 2 solenidia. Nymphs are not ptychoid and lack shields.

Remarks: Balogh (1972) follows Grandjean (1967) and also Walker (1965) in regarding this group as made up of four families, three of which are grouped into one superfamily (Euphthiracaroidea) leaving the other family in the Phthiracaroidea. This grouping has been followed here except that the superfamilies have been reranked as families and the families as subfamilies.

Family PHTHIRACARIDAE Perty

Phthiracarea Perty, 1841: 874.

Type-genus: *Phthiracarus* Perty, 1841.

Diagnosis: Euptyctima. Clearly delineated pairs of genital and anal shields, with the grestest width of each of these 4 shields more than X 0·4 their length. Lateral hysteronotal gland absent. On tarsus I, inconspicuous seta *d3* coupled to distal face of solenidium *so4*. Bothridium has associated internal tubes. Proteronotal setal file *s* with one seta. Palp with 3 segments. Lay eggs containing strongly sculptured, pigmented prelarvae.

Remarks: Following a computer-assisted Gower's Principal Co-ordinates Analysis to study phenetic affinity amongst 39 phthiracarid species, Sheals (1969) concluded that this family included a comparatively homogeneous group. The species used represented five of the eight phthiracarid genera listed by Balogh (1972). Sheals (1969) indicated that there might be two clusters, one representing *Phthiracarus* Perty and one *Steganacarus* Ewing or similar genera. Unfortunately, the species collected in this study is diagnosable as *Hoplophthiracarus*, members of which are placed between the two clusters, nearer to one or the other.

HOPLOPHTHIRACARUS Jacot

Hoplophthiracarus Jacot, 1933: 239.

Type-species: *Hoploderma histricinum* Berlese, 1908, by original designation.

Diagnosis: Proteronotal seta *j2* erect and subequal in length or longer than seta *J1*. Hysteronotum usually dimpled, carrying 15-18 pairs of setae, with only 3 pairs of pores and without conspicuous dorsal apophyses. Notal setae either tapering or parallel sided except for a ciliate tip. Anal shields carrying 2 pairs of setae in file *Ja* and 3 pairs of setae in file *Za*. At most, only 3 pairs of setae (file *Ja* and seta *Za3*) on median margin of anal shield. Seta *Za2* is the longest seta on anal shield. Femur I carries 4 setae, and genu IV carries 1 seta. On tibia IV, seta *d* may be either longer than seta *v* and uncoupled, or much smaller and coupled to a solenidium.

Distribution: Cosmopolitan. Na; NTb, NTc; Em; Pe, Pm, Ps, Pc; Os; Aa, Ap; Sk. The Antarctic is the only major region from which *Hoplophthiracarus* has not been recorded.

Found in soil, litter, moss and grass. Members of the genus have been recorded in substantial numbers from widely different environments such as *Sphagnum*-fens, deciduous and coniferous forests and high altitude *Rhododendron*-thickets.

Remarks: Hoplophthiracarus is a difficult genus to diagnose. Three of the earliest named species, including the type, are poorly known so it is not certain that the diagnosis presented above includes the entire range of attributes amongst species grouped here in the genus. Van der Hammen (1959) considered that *Hoplophthiracarus* is reminiscent of *Steganacarus* and that possibly it is only an artificial unit. On the other hand, Macfarlane and Sheals

(1965) indicate that, at that time, *Hoplophthiracarus* was only distiguished from *Phthiracarus* by having nearly erect interlamellar (*j2*) setae. Sheals (1969) included four species of *Hoplophthiracarus* in his study of phenetic affinity amongst phthiracarids. He found a close affinity between *H. nepalensis* and species of *Atropacarus* Ewing (in the *Steganacarus*-complex). The remaining three species (*H. costai*, an unnamed species from France and another from Argentina) were fairly widely scattered between the *Hoplophorella* Berlese cluster (in the *Steganacarus*-complex) and the *Phthiracarus* cluster. Sheals (1969) concluded that "as defined at present, the genus *Hoplophthiracarus* is not a natural group" and any resolution of the problem by making a nomenclatural division would require a study of the type of the genus.

One attribute often used to distinguish phthiracarid genera, flattness as opposed to the protrusion of the anal shields, has not been included in the above diagnosis. This is because the species described below has a mainly flat anal shield but with a protruding median margin (Fig. 28), which in some preserved specimens does not protrude downwards beyond the ventral margins of the hysteronotal shields, whilst in other specimens it conspicuously protrudes.

Two species, *Phthiracarus hamatus* Hammer, 1973 from the Tonga Islands—Ap and *P. tubulus* Hammer, 1972 from Tahiti—Ap, not included in *Hoplophthiracarus*, should be considered as possibly congeneric with species in this genus. The following 17 nominal species are included in *Hoplophthiracarus*: *H. cavernosus* Wallwork, 1977; *H. cazanicus* Feider and Calugar, 1969; *H. costai* Macfarlane and Sheals, 1965; *H. dactyloscopicus* Mahunka, 1978b; *H. grossmani* Jacot, 1933; *H. histricinus* (Berlese, 1908); *H. kugohi* Aoki, 1959; *H. minus* (Krivolutsky, 1965); *H. nepalensis* Sheals, 1965; *H. paludis* Jacot, 1938; *H. pavidus* (Berlese, 1913)—redescribed by van der Hammen, 1963; *H. regalis* Mahunka, 1978a; *H. robustior* Jacot, 1933; *H. shealsi* **n.sp.**; *H. siamensis* Aoki, 1965; *H. variolosa* (Berlese, 1888); *H. zebra* Balogh, 1962. There is 1 nominal subspecies: *H. histricinus nitidior* (Berlese 1923).

Hoplophthiracarus shealsi n.sp.
Fig. 21-34

Female

General appearance and measurements: Dull, straw-coloured or orange; darker specimens usually partially covered in a thin adhering layer of debris. Refractile parts (external malae, cheliceral extremities, setae and claws) paler than general integument. Much of soma covered in shallow dimples, whilst legs with very much smaller (approximately X 0.05) dimples. As well as the withdrawal of the legs and folding down of the proteronotal shield, the anal and genital shields vary in their degree of protrusion below the lateral margins of the hysteronotal shield. Hysteronotal length 600 (25, 550-665) and proteronotal length 301 (25, 270-345); appendage lengths (for 660 and 345 containing one prelarva)—*ch* 90, *pa* 120, *I* 260, *II* 240, *III* 230, *IV* 230; femur breadth—*pa* 17.5, *I* 40, *II* 32.5, *III* 27.5, *IV* 27.5.

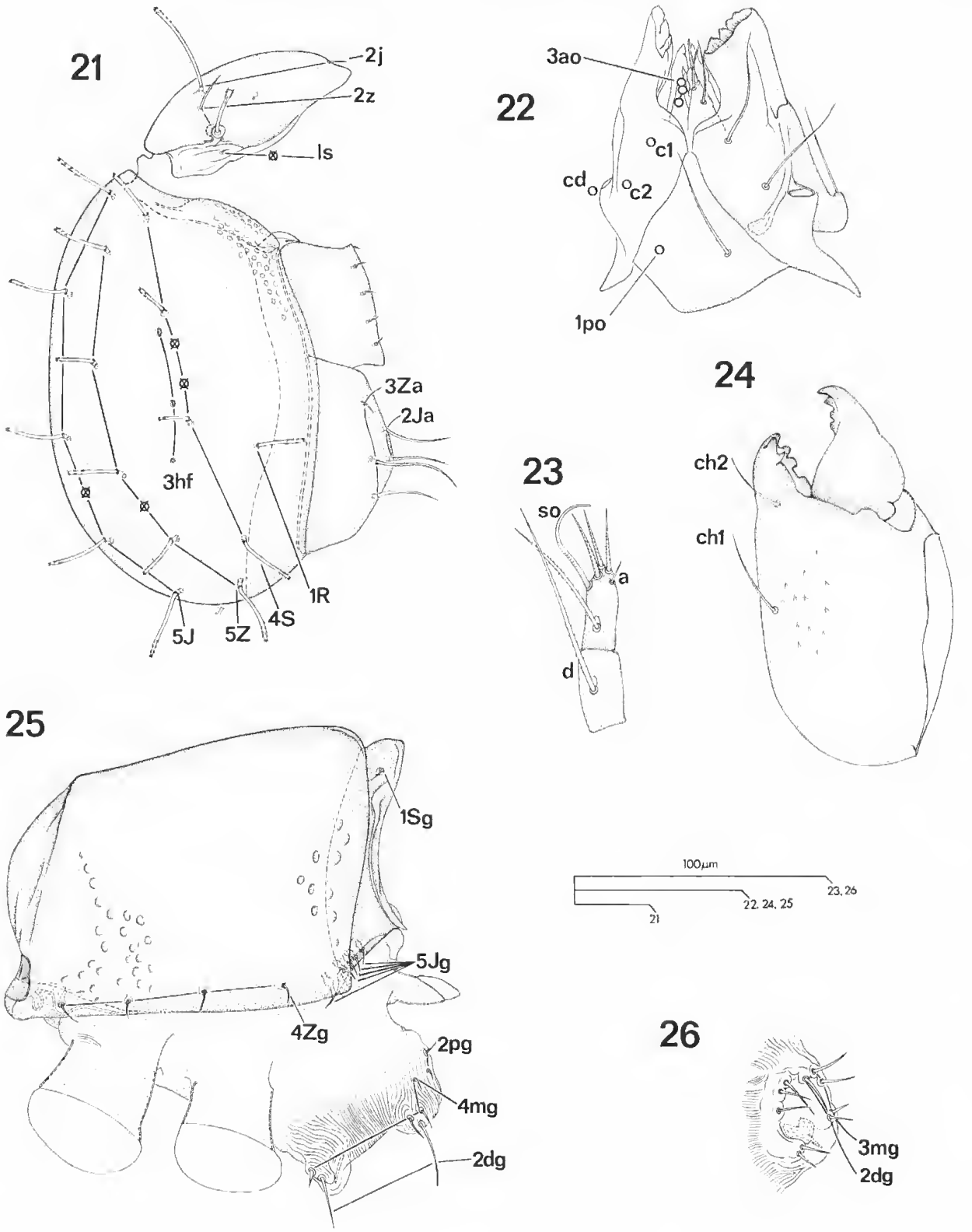
Prosternum: External malae lie in a vertical plane when in a natural position (as Fig. 31) rather than tending towards lying in a horizontal plane as when squashed (as Fig. 22). Gnathosternal setae slightly ciliate, those in file *ao* stouter and more ciliate, especially setae *ao*1 and *ao*2 (Fig. 32). Small sclerotized somal shield dorsal to where coxa II abuts onto coxa III. Coxal seta *IIp* is inconspicuous.

Proteronotum: Seta *z*2 has rows of cilia distally on ventral surface (Fig. 33) which is exposed outwards and upwards when curled around in its natural position (Fig. 21). Three long hyaline bothridial tubes curled over distally; possibly some similar but short tubes also attached to bothridial chamber (Fig. 33).

Opisthosternum: Exposed anterior anal apophysis extends from left shield in all type specimens. Anterior forward facing diaxial flap of genital shield carries four setae in file *Jg*, while *Jg*5 is on exposed ventral surface (Fig. 29). In the drawing (Fig. 25) the diaxial flap is squashed so that setal file *Jg* no longer appears vertical. Furthermore, by comparing these figures it can be seen that setae in file *Jg* are much slimmer and more tapered in appearance under a light microscope as compared with an electron microscope. The two sides of both the genital and anal shield also has a thickening which fits into a notched tuberosity on the mid-venter of the posterior margin of the hysteronotum. The anterior pair of genital papillae are less than half the size of the posterior two pairs. The ovipositor carries 16 setae, amongst which two pairs are regarded as belonging to a file *pg* which has migrated distally, so that seta *pg*2 is level with *mg*1 (Fig. 25).

Hysteronotum: A zone ventralwards of seta *R* is free of dimples (Fig. 28). The 15 pairs of setae do not taper and are ciliate distally. No vestiges of setae *J*4 and *Z*4 were observed. Only three pairs of pores in file *hf*, *hf*4 apparently absent.

Appendages: Fixed cheliceral digit distally carries two parallel rows of teeth. Setae: *ch* (2), *pa* (--1-6), *I* (3-1-4-2-5-17), *II* (0-1-3-2-3-12), *III* (1-2-2-1-2-10), *IV* (1-2-1-1-2-10). Solenidia: *pa* (--0-1), *I* (2-1-3), *II* (1-1-2), *III* (1-1-0), *IV* (0-1-0). Seta *d*1 on tarsus I is



Figs. 21-26—*Hoplophthiracarus shealsi* n.sp. 21-25, female: 21, soma excluding prosternum; 22, gnathosternum; 23, part left palp, dorsal surface; 25, left chelicera, anterior surface. 25, right genital shield and ovipositor. 26, male: spermapositor.

regarded as having migrated distally to just proximad of solenidium *so* 3. Legs monodactyl, all claws have two ventral spines on proximal half.

Eggs: Amongst 25 type females, 12 contain 0 prelarvae in eggs (although some with clear patch possibly representing developing eggs), 10 contain 1

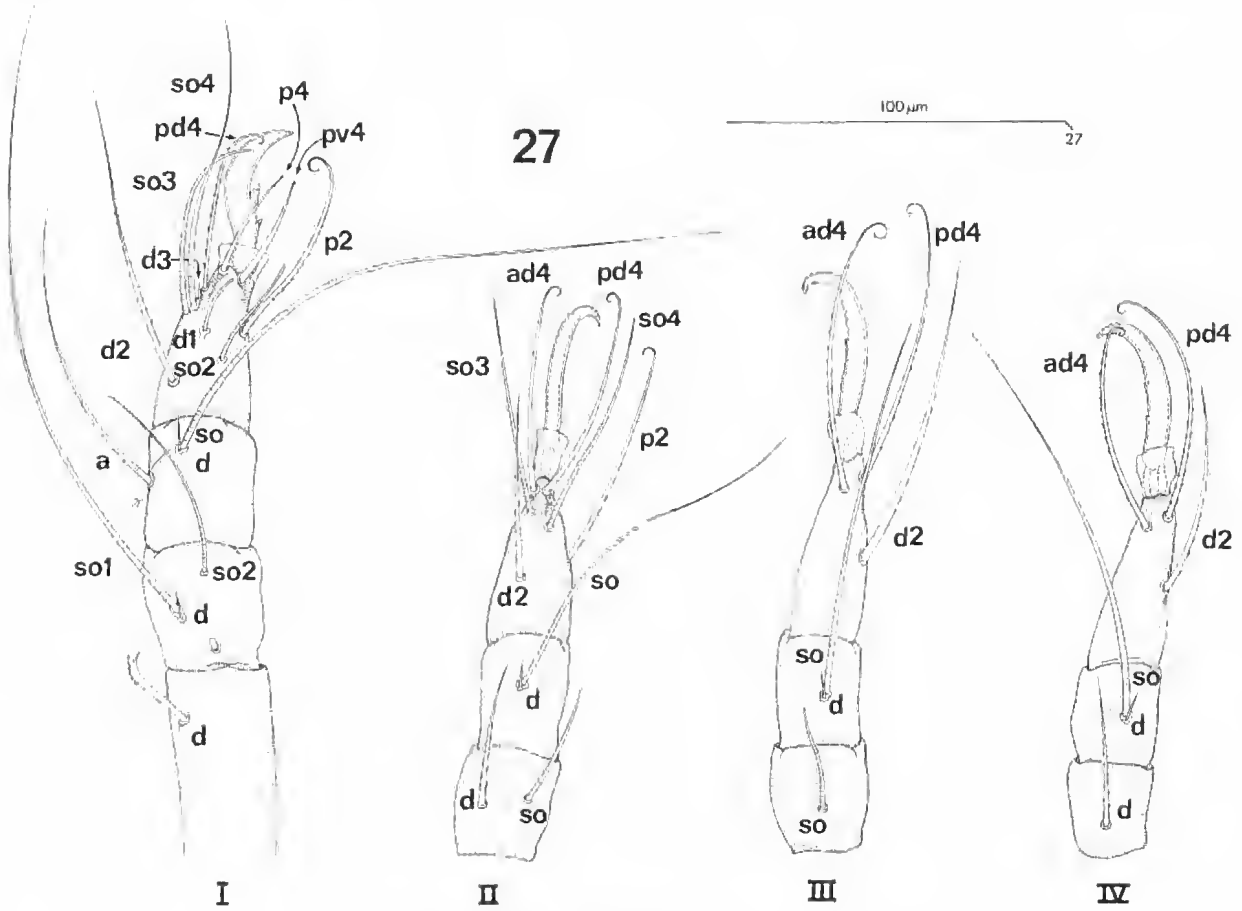


Fig. 27—*Hoplophthiracarus shealsi* n.sp., legs, dorsal setae on genua, tibiae and tarsi.

prelarva, three contain 2 prelarvae. Prelarvae about 220µm long and similar to that described for *Hoplophthiracarus pavidus* by van der Hammen (1963).

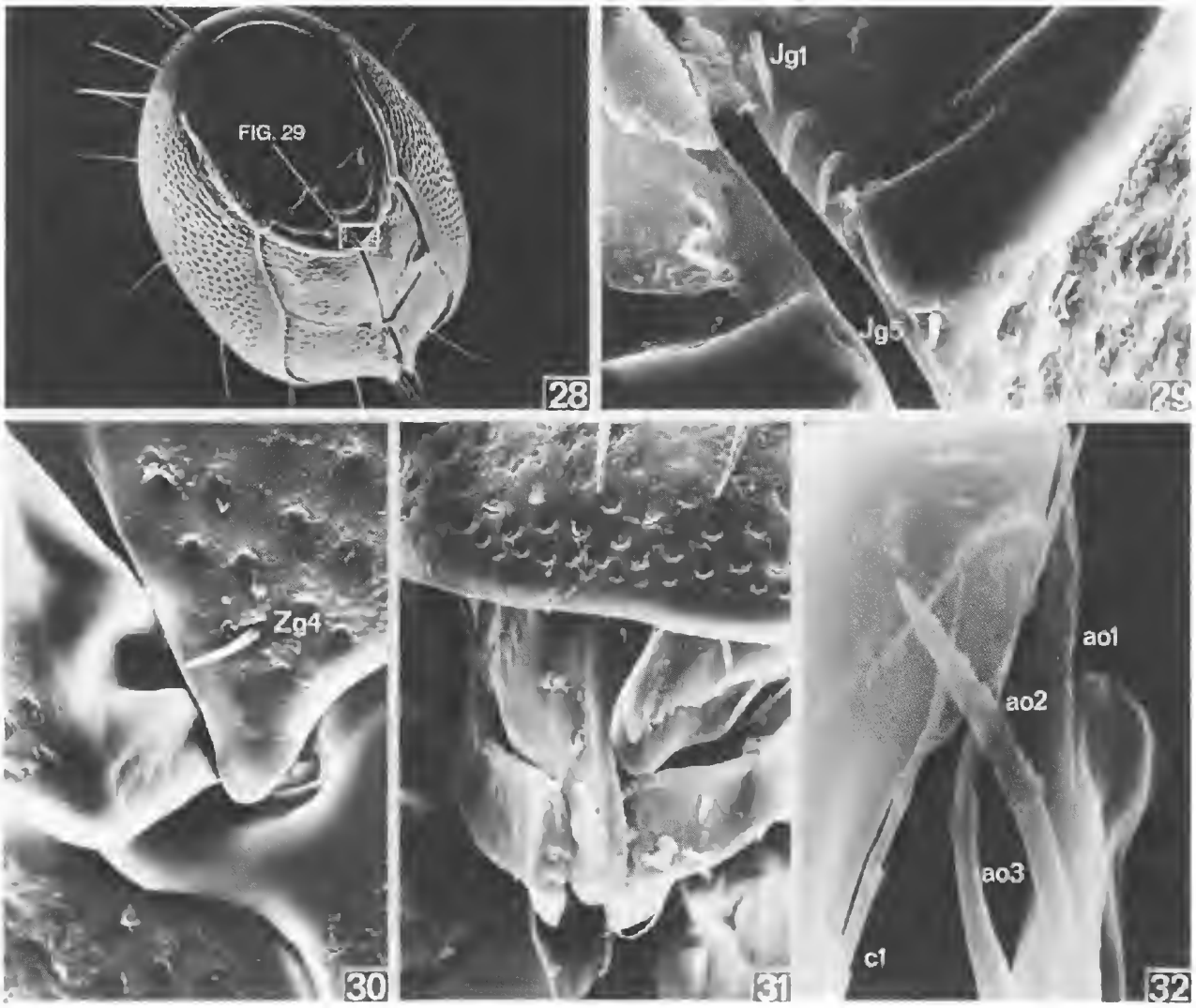
Male

Measurements and spermapositor (otherwise as female): Hysteronotal length 485 (25, 425-545) and proteronotal length 250 (25, 210-280). Spermapositor carries 10 setae which are relatively even in length compared to those on the ovipositor.

Material examined: Holotype female (N197649), 24 paratype females (N197650-N197673), allotype male (N197674) and 24 paratype males (N197675-N197698), litter under *Pinus pinea*, Knott Hill Forest, 22.5.1974, D. C. Lee. Sixteen undesignated goldcoated specimens on stub ARAS2, as above except collected on 24.11.1976.

Distribution: South Australia—Aa: Knott Hill, cultivated pine forest, 319 (2/2); Mt. Lofty, sclerophyll forest, 2 (2/8).

Remarks: The diagnosis of this species is difficult because of the inadequate description of some previously named species. If the descriptions of the latter are accurate as far as they go, *H. shealsi* can be recognised by possessing the following five groups of attributes: 1—hysteronotal shield dimpled, without numerous long furrows, also lacks a conspicuous pair of posterior concavities each side of a knob-like protruberance opposing posterior edges of anal shields; 2—15 pairs of blunt, distally ciliate hysteronotal setae; 3—solenidium on tibia IV coupled with a small dorsal seta; 4—aggenital setae of file *Jg* in a straight vertical line; 5—of the two shorter adanal setae in file *Za*, *Za*1 subequal in length to aggenital setae (X 0.9-1.1)and *Za*3 subequal in length to setae in file *Ja* (X 0.9-1.1). The setal alignment of file *Jg* in a straight vertical line is only otherwise described on *H. cavernosus* amongst species of *Hoplophthiracarus*, although it does occur on *Notophthiracarus australis* Ramsay, 1966, from New Zealand—An. If further studies support the uniqueness of this species, then it may be that it is endemic to Australia although occurring in large numbers only in the litter of an introduced conifer. It should also be noted that based on the two characters used by Sheals (1969) to distinguish the two groups into which he divides his four species of *Hoplophthiracarus*, *H. shealsi*, by having both 15 pairs of hysteronotal setae and a coupled solenidium on tibia IV, has one diagnostic attribute of each group.



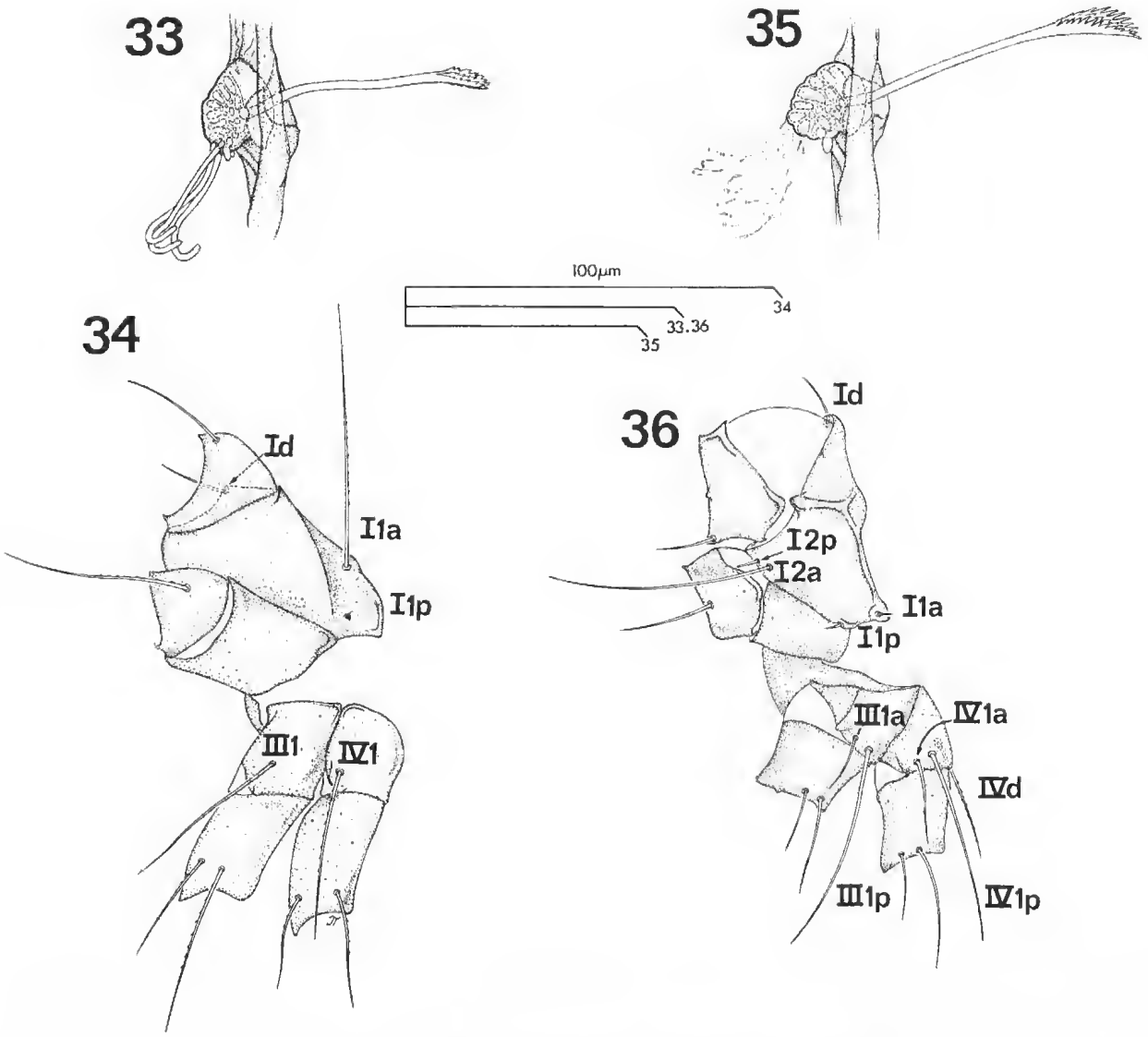
Figs. 28-32—*Hoplophthiracarus shealsi* n.sp., female: 28, hysteronotal, genital and anal shields, ×140; 29, anterior genital shields as indicated in Fig. 28, ×2100; 30, mid-venter where anal and genital shields abut, ×1400; 31, anterior proteronotum and gnathosternum, ×700; 32, parts of right internal and external malae, ×3500.

Family EUPHTHIRACARIDAE Jacot
Euphthiracarini Jacot, 1930: 214.

Type-genus: *Euphthiracarus* Ewing, 1917.

Diagnosis: Euptyctima. Genital and anal shields may or may not be separated from ventral shield by a suture, but in both cases lateral margin of ventral shields unbroken for entire length of opisthosternum. Lateral hysteronotal gland present or absent. On tarsus 1, seta *d*3 conspicuous and not coupled to a solenidium. Bothridium may have associated internal filaments or, rarely, internal tubes. Proteronotal setal file *s* with 1 or 2 setae. Palp with 3, 4 or 5 segments. Either lay eggs with or without ornate chorion, or containing a strongly sculptured, pigmented prelarvae.

Remarks: The results of a computer-assisted Gower's Principal Co-ordinates Analysis of phenetic affinity amongst 53 Euptyctima species indicated that the Euphthiracaridae is not so homogeneous as the Phthiracaridae, since the first generic separation occurs at the 74 per cent rather than the 90 per cent phenon line (Sheals, 1969). In that study the 14 species of euphthiracarid, representing 7 genera, separate into three groups at the 74 per cent phenon line: two within Oribotritinae, one within Euphthiracarinae. Therefore, it appears preferable to follow Märkel (1964) and group 'non-phthiracarid' Euptyctima in one family, but maintain subfamilies equivalent to the families listed in Walker (1965). The Oribotritiinae Grandjean, 1954a and Synichotritiinae Walker, 1965 have not been collected in the present study, while the other subfamily is considered below.



Figs. 33-36—Ventral view of setae *z*2 and podosterna. *Hoplophthiracarus shealsi* n.sp., female: 33, seta *z*2 plus associated bothridial structures; 34, coxae and trochanters I-IV. *Rhysotritia wallworki* n.sp., female: 35, seta *z*2 plus associated bothridial structures; 36, coxae and trochanters I-IV.

Subfamily EUPHTHIRACARINAE Jacot

Euphthiracarini Jacot, 1930: 214

Type-genus: *Euphthiracarus* Ewing, 1917.

Diagnosis: Euphthiracaridae. Anal shield with anterior triangular corrugated area. Anogenital suture present but often limited to breadth of corrugated triangle. Anal and genital shields fused with ventral shield so that no line of demarcation separates them. Lateral hysteronotal gland present. Palp with 3 segments. Lay eggs with ornate chorion or a smooth chorion and containing a larva.

RHYSOTRITIA Märkel and Meyer

Rhysotritia Märkel and Meyer, 1959: 329.

Type-species: *Hoplophora ardua* C. L. Koch, 1841, by original designation.

Diagnosis: Bothridial flap dorsal to seta *z*2. Distance between setal bases *j*2-*j*2 less than twice distance between setal bases *j*2-*z*2. Seta *j*2 approximately twice as long as *j*1. On genital shields, between 7 and 11 pairs of setae. Posterior corrugations on anal shields. Pore *Zaf* subcircular and never nearer triangular corrugated area than it is to seta *Za*1. Seta *Ja*1 recognisable but small. Setae *Ja*2 and *Ja*3 shorter than *Za*1 and *Za*2. On genu IV, no solenidium.

Distribution: Widespread. NTc; Pe, Ps; Aa, Ap. Species from North America, previously included in *Rhysotritia*, are now grouped in *Microtritia* Märkel, 1964.

Found in decaying wood, humus and moss. A number of ecological studies indicate some members of this genus occur in the deeper more compact layers of the lower fermentation zone and the upper part of the humus zone, whilst some species of Phthiracaridae occur in zones above them.

Remarks: One attribute used by Balogh (1972) to distinguish *Rhysotritia* is not comprehensive enough because *R. clavata sextiana* has only one pair of setae on both trochanters III and IV. The diagnosis used here is based on that of Märkel (1964).

The following 4 nominal species are included in *Rhysotritia: R. ardua* (Koch, 1841); *R. calvata* Märkel, 1964; *R. duplicata* (Grandjean, 1953); *R. wallworki* **n.sp.** There are 4 nominal sub-species: *R. ardua otaheitensis* Hammer, 1972; *R. ardua penicillata* Pérez-Iñigo, 1969; *R. calvata sextiana* Lions, 1966; *R. duplicata limbata* (Märkel and Meyer, 1959).

Rhysotritia wallworki n.sp.
Fig. 35-42

Female

General appearance and measurements: Dull, ivory-white with pinkish edges to shields. Refractile parts (external malae, cheliceral extremities, setae and claws) paler than general integument. Most of soma covered by fine pores (Fig. 41). Hysteronotal length 390 (5, 360-415) and proteronotal length 240 (5, 225-255); appendage lengths (for 410 and 245), *ch* 60, *pa* 97.5, *I* 185, *II* 170, *III* 167.5, *IV* 167.5; *femur breadth—pa* 15.5, I 37.5, *II* 27.5, *III* 25, *IV* 22.5

Prosternum: External malae are curved, tending to form a cylinder around the chelicerae. Only seta *cd* on gnathosoma appears to be even slightly ciliate. Long sclerotized somal shield dorsal to and between coxae II and III. Coxa I as drawn (Fig. 36) is swivelled round so that anterior surface is facing ventralwards.

Proteronotum: Seta *z*2 has rows of cilia distally on ventral surface (Fig. 35) which is exposed forwards and outwards when curled around in its natural position (Fig. 37). A number of granular filaments extend inwards from bothridial chamber (Fig. 35) and disappeared when cleared. Presumably these are "tracheoles". From their appearance in this species it is possible that they are the outer layers of a series of tubes. Only two ridges radiate forward from bothridium.

Opisthosternum: Small anterior forward facing diaxial flap on genital shield. All setae in file *Jg* are in a straight horizontal line inside grooves on opposing faces of midventral division between genital shields. There are small interlocking corrugations at posterior end of anal shield. Ovipositor carries 12 setae; apparently file *pg* is unrepresented. The positor is assumed female because of the large size of the setae in file *dg* (Fig. 40).

Hysteronotum: The 14 pairs of setae are slighty ciliate and tapered. The fine pores represented by spots (Fig. 41) show up as lines in profile, possibly being narrow ducts running as deep as the long outer chambers at the setal bases. Five pairs of pores in file *hf*, with a conspicuous duct to hysteronotal gland opening near *hf*3.

Appendages: Chelicerae with relatively small teeth. Setae: *ch* (2), *pa* (--2-8), *I* (5-1-3-3-5-17), *II* (0-1-3-3-4-13), *III* (2-2-2-23-11), *IV* (3-2-1-1-2-9). Solenidia: *pa* (--0-1), *I* (2-1-3), *II* (1-1-2), *III* (1-1-0), *IV* (0-1-0). All solenidia on genua and tibiae are coupled with a dorsal seta, but the bases of the couples appear to be discrete rather than merged as in *Hoplophthiracarus shealsi* described above. Seta *d*1 on tarsus I is stout with annular wrinkles and is regarded as having migrated distally to be level with solenidium *so*4. The setal pair *av*1 and *pv*1 on tarsus II are absent. Each pretarsus with a single claw having 2 inconspicuous ventral spines on proximal half.

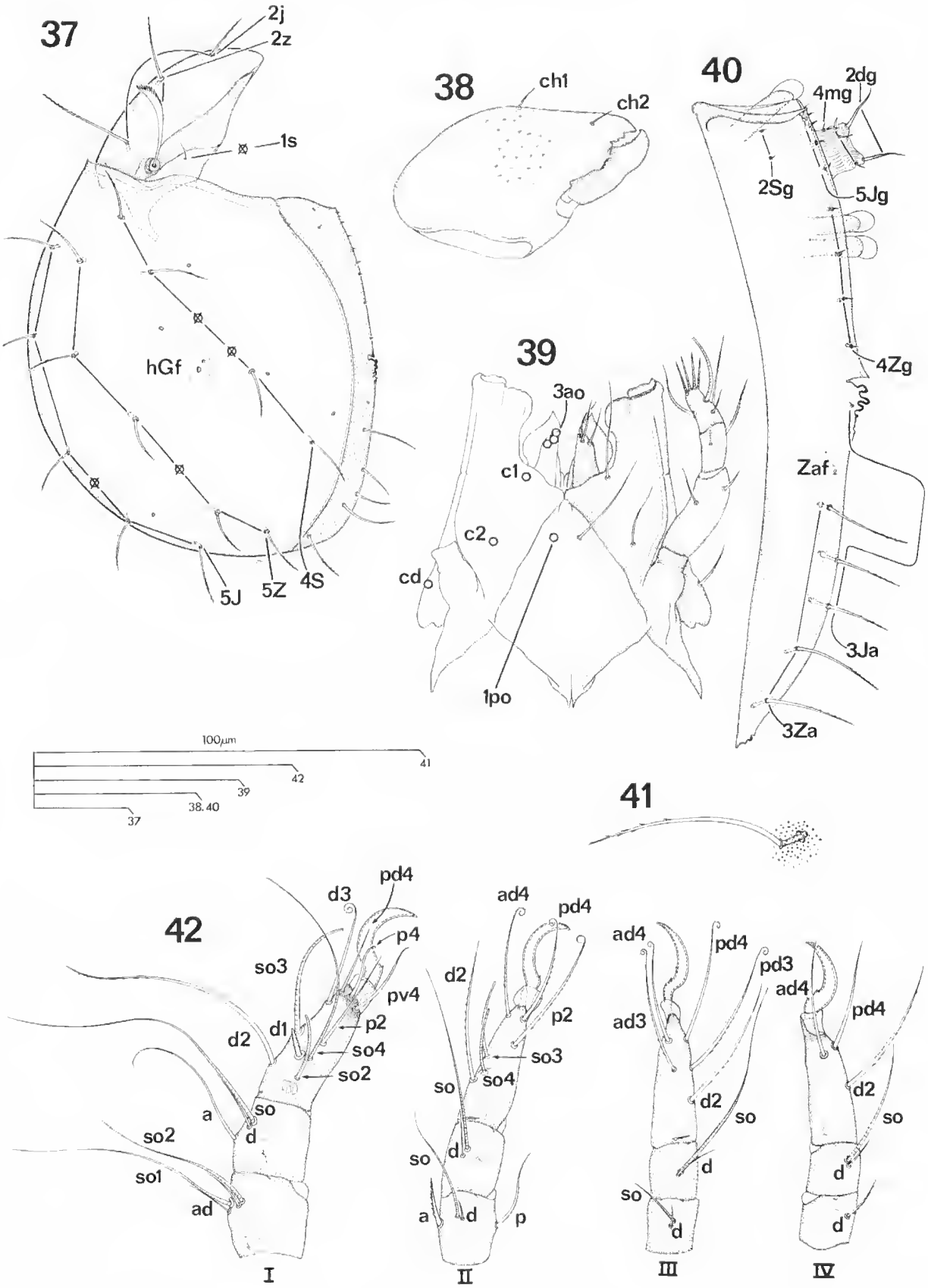
Male

Unknown.

Material examined: Holotype female (N197699), 2 paratype females (N1976100 and N1976101), litter under *Acacia sophorae*, Piccaninnie Ponds Reserve, 3/7/1974, D. C. Lee. Two paratype females (N1976102 and N1976103) litter and grass under *Eucalyptus viminalis*, Chambers Gully, 12/6/1974, D. C. Lee.

Distribution: South Australia-Aa: Piccaninnie Ponds, coastal shrubland, 3(2/8); Chambers Gully, savannah woodland, 2(1/8).

Remarks: Considering the similarity between the species of this genus and the relatively substantial differences between some subordinate subspecies and their type subspecies, it is difficult to decide how to classify new material. *R. wallworki* can be clearly distinguished from *R. duplicata* which is tridactyl, has an extra ridge running forward from dorsal margin of bothridial flap, and setae *av*1 and *pv*1 present on tarsus II. *R. ardua* differs in being either bidactyl or tridactyl and having a slim seta *z*2. On the other hand *R. clavata* is similar, but *R. wallworki* is distinguished by four attributes: longer cilia on notal setae including *z*2, 11 pairs of setae on the genital shields, only a very indistinct notch in the bothridial flap and 17 setae on tarsus I. But it should be noted that two of the characters involved, the



Figs. 37-42—*Rhysotritia wallworki* n.sp., female: 37, soma, excluding prosternum; 38, left chelicera, anterior surface; 39, gnathosternum; 40, right anogenital shield plus partially extruded ovipositor; 41, hysteronotal seta *J3*; 42, dorsal setae on genua, tibiae and tarsi.

setation of the genital shield and tarsus I, vary within the species *R. clavata* (including *R.c.sextiana*), although not to the extent of overlapping with *R. wallworki*.

ACKNOWLEDGEMENTS

I am indebted to the Interim Council of the Australian Biological Resources Study for funds for equipment, and to the Mark Mitchell Research Foundation and to the Science and Industry Endowment Fund for funds for travel in connection with this project. Two species, *Stomacarus abresi* and *Loftacarus siefi*, have names based on acronyms for two of these funding bodies.

Special thanks are due to Dr J. G. Sheals for arranging bench space for me at the British Museum (Natural History), London, and to Dr J. A. Wallwork, Westfield College, London, for advice in the initial stage of this project. Thanks are also due to Dr B. G. M. Jamieson, University of Queensland, Brisbane for commenting on the manuscript.

My greatest debt of gratitude is to Ms Linda Blesing for preparing some drawings (Figs. 1-9) and to Ms Jenni Thurmer for preparing most drawings (Figs. 10-42). Thanks are also due to Ms Jan Forrest for preparing the photographic prints and to Ms Debbie Melloy for typing this manuscript.

REFERENCES

AOKI, J. 1959. Die Moosmilben (Oribatei) aus Sü-Japan. *Bull. biogeogr. Soc. Japan* **21:** 1-22.

AOKI, J. 1965. Oribatiden (Acarina) Thailands. 1. *Nature Life Southeast Asia* **4:** 129-193.

BALOGH, J. 1962. New Oribatids from Madagascar (Acari). *Annls hist.-nat. Mus. natn. hung. (Zool.)* **54:** 419-427.

BALOGH, J. 1972. *The oribatid genera of the world*. Akademiai Kiado, Budapest. 188 pp. 71 pls.

BALOGH, J., and CSISZÁR, J. 1963. The Zoological Results of Gy. Topál's Collectings in South Argentina. 5. Oribatei (Acarina). *Annls hist.-nat. Mus. natn. hung. (Zool.)* **55:** 463-485.

BERLESE, A. 1888. Acari Austro-Americani quos collegit Aloysius Balzan. *Boll. Soc. ent. ital.* **20:** 171-222.

BERLESE, A. 1904. Acari nuovi. Manipulus III. *Redia* **2:** 10-32.

BERLESE, A. 1908. Elenco di generi e specie nuove di Acari. *Redia* **5:** 1-15.

BERLESE, A. 1910. Acari nuovi. Manipulus V, VI. *Redia* **6:** 199-234.

BERLESE, A. 1913. Acari nuovi. Manipoli VII-VIII. *Redia* **9:** 77-111.

BERLESE, A. 1916. Centuria prima di Acari nuovi. *Redia* **12:** 19-67.

BERLESE, A. 1923. Centuria sesta di Acari nuovi. *Redia* **15:** 237-262.

EVANS, G. O. 1963. Observations on the chaetotaxy of the legs in the free-living Gamasina (Acari: Mesostigmata). *Bull. Br. Mus. nat. Hist. (Zool.)* **10:** 277-303.

EWING, H. E. 1917. A synopsis of the genera of beetle mites with special reference to the North American fauna. *Ann. ent. Soc. Am.* **10:** 117-132.

FIEDER, Z., and CĂLUGĂR, M. 1969. Chetotaxia picioarelor la speciile genurilor *Phthiracarus* si *Hoplophthiracarus* (Oribates), din România. *Anal. Stiint. Univ. 'Al. I. Cuza' (Sect. 2A)* **15:** 1-6, 6 pls.

GRANDJEAN, F. 1932a. La famille des Protoplophoridae (Acariens). *Bull. Soc. zool. Fr.* **57:** 10-36.

GRANDJEAN, F. 1932b. Au sujet des Palaecariformes Trägårdh. *Bull. Mus. natn. Hist. nat., Paris* (2)**4**: 411-426.

GRANDJEAN, F. 1935. Les poils et les organes sensitifs portés par les pattes et le palpe chez les Oribates. *Bull. Soc. zool. Fr.* **60:** 6-39.

GRANDJEAN, F. 1939. L'évolution des ongles chez les Oribates (Acariens). *Bull. Mus. natn. Hist. nat., Paris* (2) **11:** 539-546.

GRANDJEAN, F. 1940a. Observations sur les Oribates (13e série). *Bull. Mus. natn. Hist. nat., Paris* (2) **12:** 62-69.

GRANDJEAN, F. 1940b. Les poils et les organes sensitif portés par les pattes et le palpe chez les oribates. Deuxième partie. *Bull. Soc. zool. Fr.* **65:** 32-44.

GRANDJEAN, F. 1952a. Observations sur les Palaeacaroides (Acariens) (1re série). *Bull. Mus. natn. Hist. nat., Paris* (2) **24:** 360-367.

GRANDJEAN, F. 1952b. Observations sur les Palaeacaroides (2e série). *Bull. Mus. natn. Hist. nat., Paris* (2) **24:** 460-467.

GRANDJEAN, F., 1953. Observations sur les Oribates (25e série). *Bull. Mus. natn. Hist. nat., Paris* (2) **25:** 155-162.

GRANDJEAN, F. 1954a. Essai de classification des Oribates (Acariens). *Bull. Soc. zool. Fr.* **78:** 421-446.

GRANDJEAN, F. 1954b. Les Enarthronota (Acariens) (4e série). *Annls. Sci. nat., Zool.* (11) **16:** 311-335.

GRANDJEAN, F. 1954c. Étude sur les Palaeacaroides (Acariens, Oribates). *Mém. Mus. natn. Hist. nat., Paris (N.S.), sér. A, Zool.* **7:** 179-274.

GRANDJEAN, F. 1957. Observations sur les Palaeacaroides (4e série). *Bull. Mus. natn. Hist. nat., Paris* (2) **29:** 213-220.

GRANDJEAN, F. 1958a. Observations sur les Palaeacaroides (5e série). *Bull. Mus. natn. Hist. nat., Paris* (2) **30:** 76-83.

GRANDJEAN, F. 1958b. Au sujet du naso et de son oeil inféré chez les Oribates et les Endeostigmata (Acariens). *Bull. Mus. natn. Hist. nat., Paris* (2) **30:** 427-435.

GRANDJEAN, F. 1965. Nouvelles observations sur les Oribates (4e série). *Acarologia* **7:** 91-112.

GRANDJEAN, F. 1967. Nouvelles observations sur les Oribates (5e série). *Acarologia* **9:** 242-272.

GRANDJEAN, F. 1969. Considérations sur le classement des Oribates. Leur division en 6 groupes majeurs. *Acarologia* **11:** 127-153.

HAMMEN, L. van der 1959. Berlese's primitive Oribatid mites. *Zool. Verh., Leiden* **40:** 1-93.

HAMMEN, L. van der 1963. The Oribatid family Phthiracaridae. I. Introduction and redescription of *Hoplophthiracarus pavidus* Berlese. *Acarologia* **5:** 306-317.

HAMMER, M. 1967. Investigations of the Oribatid fauna of New Zealand, part II. *Biol. Skr.* **15** (4): 1-64, 40 pls.

HAMMER, M. 1972. Investigations on the Oribatid fauna of Tahiti, and on some oribatids found on the atoll Rangiroa. *Biol. Skr.* **19** (3): 1-92, 26 pls.

HAMMER, M. 1973. Oribatids from Tongatapu and Eua, the Tonga Islands, and from Upolu, Western Samoa. *Biol. Skr.* **20** (3): 1-71, 29 pls.

HIRSCHMANN, W. 1957. Gangsystematik der Parasitiformes. Teil I. Rumpfbehaarung und Rückenflächen. *Acarologie, SchrReihe vergl. Milbenk., Fürth* **1:** 1-20, i-v, 26 pls.

HUGHES, T. E. 1959. *Mites or the Acari*. University of London: 225 pp.

JACOT, A. P. 1930. Oribatid mites of the subfamily Phthiracarinae of the Northeastern United States. *Proc. Boston Soc. nat. Hist.* **39:** 209-261, 10 pls.

JACOT, A. P. 1933. Phthiracarid mites of Florida. *J. Elisha Mitchell scient. Soc.* **48:** 232-267.

JACOT, A. P. 1938. More box-mites of the Northeastern United States. *Jl. N.Y. ent. Soc.* **46:** 109-145.

KOCH, C. L. 1841. 'Deutschlands Crustaceen, Myriapoden und Arachiden'' *vol.* **32** (15), Regensburg (not seen).

KRANTZ, G. W. 1978. "A manual of Acarology." Oregon State University: 509 pp.

KRIVOLUTSKY, D. 1965. New species of armoured mites (Acariformes; Oribatei) from the taiga zone of the USSR. *Ent. Obozr.* **44:** 705-708 (in Russian, not seen).

LANGE, A. B. 1954. The morphology of *Zachvatkinella belbiformes* gen.n. and sp.n.—an interesting species of Palaeacariformes (Acariformes). *Zool. Zh.* **33:** 1042-1052 (in Russian).

LANGE, A. B. 1972. New species of palaeacarid mites (Palaeacaridae). *Vest. mosk. gos. Univ. (Biol.)* **4:** 103-106 (in Russian, not seen).

LANGE, A. B. 1974. *Gilarovella demetri* Lange, gen. nov. and sp. nov.—a new representative of palaeacaroid mites (Palaeacaroidea, Ctenacaridae) from Turkmenia. *Vest. mosk. gos. Univ., N.S.* **1:** 18-20 (in Russian, not seen).

LANGE, A. B. 1975. Sarcoptiformes. Palaeacaroidea: 41-47—In: M. S. Ghilarov, ed., *Identification Key to the soil-dwelling mites*, Academy of Sciences, USSR, Moscow: 491 pp (in Russian).

LEE, D. C. 1970. The Rhodacaridae (Acari: Mesostigmata); classification, external morphology and distribution of genera. *Rec. S. Aust. Mus.* **16:** 1-219.

LEE, D. C. 1973. Rhodacaridae (Acari: Mesostigmata) from near Adelaide, Australia. II. Ecology. *Trans. R. Soc. S. Aust.* **97:** 139-152.

LINDQUIST, E. E. and EVANS, G. O. 1965. Taxonomic concepts in the Ascidae, with a modified setal nomenclature for the idiosoma of the Gamasina (Acarina: Mesostigmata). *Mem. ent. Soc. Can.* **47:** 1-64.

LIONS, J. C. 1966. Contribution a l'étude du genre *Rhysotritia* (Acarien, Oribate): *Rhysotritio clovata sextiana* n. subsp. *Vie Milieu* **17:** 779-794.

MACFARLANE, D. and SHEALS, J. G. 1965. A new phthiracarid mite from Israel. *Acorologia* **7:** 577-583.

MAHUNKA, S. 1974. Neue und interssante milben aus dem Genfer Museum. XI. *Archs. Sci., Genève* **26:** 205-225.

MAHUNKA, S. 1977. Neue und interssante milben aus dem Genfer Museum XXXI. A remarkable sample of archaic soil mites from Kenya (Acari: Oribarida). *Revue suisse Zool.* **84:** 463-479.

MÄRKEL, K. 1964. Die Euphthiracaridae Jacot 1930, und ihre Gatturgen (Acari, Oribatei). *Zool. Verh. Leiden* **67:**1-78.

MÄRKEL, K. and MEYER, I. 1959. Zur Systematik der deutschen Euphthiracarini. *Zool. Anz.* **163:** 327-342.

MORITZ, M. 1974. Beiträge zur Kenntnis der Oribatiden (Acari) Europas VI. *Neoctenacarus hostilis* nov. gen., nov. spec., eine neue Ctenacaride aus der DDR (Palaeosomata, Ctenacaroidea). *Abh. Ber. NaturkMus.-ForschStelle, Görlitz* **48:** IV/1—IV/14.

NEWELL, I. M. 1956. The new genus *Tetracondyla* in the Pacific (Acari: Oppiidae). *Proc. Howaii ent. Soc.* **16:** 113-121.

NEWELL, I.M. 1957. A new genus and species of Oribatei (Acari) exhibiting external sexual dimorphism. *Proc. Howaii ent. Soc.* **16:** 298-306.

PÉREZ-INIGO C., 1969. Nuevos oribátidos de seulos espanoles (Acari, Oribatei). *Eos, Wien* **44:** 377-402.

PERTY, M. 1841. "Allgemein Naturgeschichte, als Philosopische und Humanitätswissenschaft für Naturforscher, Philosophen und das höher gebildete Publikum" 3, Bern (not seen).

RAMSAY, G. W. 1966. Three new box-mites (Acari: Oribatei: Phthiracaroidea) from the Brothers, Cook Strait, New Zealand. *N.Z. Jl Sci.* **9:** 901-912.

SCHWEIZER, J. 1956. Die Landmilben des Schwiezerischen National-parkes. 3. Teil: Sarcoptiformes Reuter 1909. *Ergebn. wiss. Unters schweiz. NothParks, N.F.* **5:** 215-377.

SELLNICK, M. 1944. *Zercon* C. L. Koch *Acari, Bl. Milbenk.* **5:** 30-41.

SHEALS, J. G. 1965. Primitive Cryptostigmatid mites from rhodendron forests in the Nepal Himalaya. *Bull. Br. Mus. nat. Hist. (Zool.)* **13:** 1-35.

SHEALS, J. G. 1969. Computers in Acarine Taxonomy. *Acorologio* **11:** 376-396.

SOUTHCOTT, R. V. 1961. Studies on the systematics and biology of the Erythraeoidea (Acarina), with a critical revision of the genera and subfamilies. *Aust. J. Zool.* **9:** 367-610.

SPAIN, A. V., and LUXTON, M. 1971. Catalog and bibliography of the Acari of the New Zealand Subregion. *Pacif. Insects Monogr.* **25:** 179-226.

SPECHT, R. L. 1972. "The vegetation of South Australia". Government Printer, Adelaide: 328 pp.

TRÄGARDH, I. 1906. Neue Acariden aus Natal und Zululand. *Zool. Anz.* **30:** 870-877.

TRÄGARDH, I. 1932. Palaeacariformes, a new suborder of Acari. *Ark. Zool.* **24B(2):** 1-6.

TRAVÉ, J. 1964. *Andacarus watsoni*, n.sp. (Acarien, Oribate) de l'ile Macquarie. *Pocif. Insects Monogr.* 7 *(Suppl.):* 647-652.

WALKER, N. A. 1965. Euphthiracaroidea of California Sequoia Litter; with a reclassification of the families and genera of the world (Acarina: Oribatei). *Fort Hays Studies—Science. N.S.* **3:** 1-154.

WALLWORK, J. A. 1966. More oribatid mites (Acari: Cryptostigmata) from Campbell I. *Pocif. Ins.* **8:** 849-877.

WALLWORK, J. A. 1977. La faune terrestre de l'Ile de Sainte-Hélène. 4. Acarina. 4.1 Cryptostigmata. *Annls. Mus. r. Afr. cent. 8° Sci. Zool.* No. **220:** 189-257.

WOOLLEY, T. A. 1971. Taxonomy of oribatid mites—retrospect and prospect. *Int. Congr. Acarology:* **3.** *Prague:* 337-341.

ZACHVATKIN, A. A. 1945a. On the discovery of Palaeacariformes (Acarina) in the U.S.S.R. *Dokl. Akod. Nauk. U.S.S.R. for Long. Edn.* **47:** 673-676.

ZACHVATKIN, A. A. 1945b. On the morphology of *Beklemishevio goleodulo* n.g. and n.sp.—a new member of the group Palaeacariformes (Acarina). *Byull. mosk. Obshch. Ispyt. Prir., Biol. N.S.* **50:** 60-71 (in Russian).